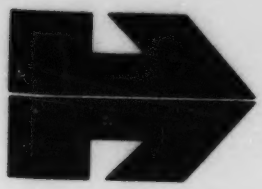

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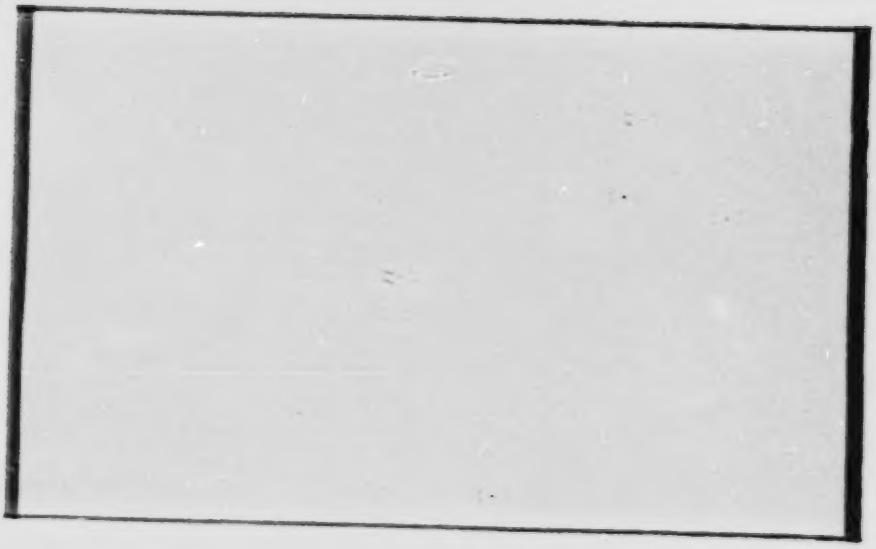

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WORKING PAPER NO. 12

METROPOLITAN VANCOUVER: INDUSTRIAL DECENTRALIZATION AND PORT ACTIVITY ON THE LOWER FRASER RIVER

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ABSTRACT

The suburban Lower Fraser River industrial community within Metropolitan Vancouver was examined with the objective of evaluating the factors of production, transportation requirements, and interindustry linkages to explain the intrametropolitan movement of manufacturing. The influence of the adjacent deepwater Fraser River Port on this movement was also assessed.

By examining the spatial variations in production costs, it was demonstrated that capital-intensive manufacturing gravitated to suburban locations, where fixed capital costs, especially land costs, were lowest. Labour-intensive manufacturing concentrated in the central city where labour costs were lowest. Fraser River manufacturing maintained substantial marine transportation linkages in two forms: direct use of the waterway at private docks and indirect use through central docking facilities.

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J. E. Randall

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CHAPTER 1
INTRODUCTION

Since the 1940s geographers have conducted a large number of descriptive and statistical analyses of the process of industrial decentralization within the metropolis. The factors stated to be responsible for spatial shifts in industrial production are as numerous and diverse as the studies from which they are cited. However, it is possible to condense these many forces into several basic site selection factors that arise as a result of changes in the structure of production of the capitalist firm in its attempt to maximize profit.

At the metropolitan scale, this sequence of events is influenced by the following four major factors: (1) capital inputs in the form of land, plant and equipment, and commodity capital; (2) distribution costs, including inter-industry linkages and transportation costs; (3) intraurban wage rate differentials and associated labour market variables; and (4) agglomerative forces.

The influence of these factors on industrial location has long been recognized at the regional and national scale. However, when discussed in terms of intrametropolitan movement of manufacturing (i.e., site selection as opposed to regional locational selection) their influence has commanded less recognition.

Weberian industrial location theory incorporates most of these factors within its basic theoretical

framework, particularly with respect to transport costs, associated industrial linkages, and labour cost differentials. Despite this the model has been criticized for being static, demanding the acceptance of unrealistic assumptions, and failing to describe adequately the processes affecting the modern urban and industrial milieu. The basic view, however, that capitalist firms will attempt to minimize production costs serves as an effective basis for an investigation of the process involved in intrametropolitan manufacturing location, and an integral component of this process, suburban industrial decentralization.

It may be argued that the Löschian locational framework, advocating a demand approach to the problem, is more suitable. However, within a metropolis, product price, revenue, and distribution costs for a given level of output are relatively constant for alternate sites. As such, the local market approaches nodal rather than areal proportions, and the underlying factors influencing location of industry are more aptly considered from a cost minimization approach.

It can be conceded that market accessibility is most important for some manufacturing activities at some scales of operation. Those activities requiring constant contact with suppliers, clients, and services found at the central market (e.g., commercial printers, custom jewellers), and those firms operating on a small scale that utilize the external economies of scale found at the city centre, often select their site based on market considerations. Although the minimization of

production costs remains an element of the site selection process, proximity to market eclipses these cost considerations in importance.

In addition, specific factors (e.g., political tax incentives, inequitable provision of services) may be the overriding determinants of industrial location for an individual site. However, when viewed in a global perspective, these factors are deviations rather than encompassing explanations.

The purpose of this study is to examine the influence of the four locational factors mentioned in the context of a suburban industrial waterfront district in a major metropolitan centre. Specifically, the study area is located adjacent to the Fraser River in the Greater Vancouver Regional District, approximately twenty kilometres from Vancouver's Central Business District. The existence of a navigable deep water (40 feet) river, and the presence of port facilities for the transshipment of cargo, differentiates this study area from other metropolitan suburban industrial sites. Any study of peripheral industry must be carried out with the realization that there is an innate association between factors affecting central city and suburban industrial change. This association is even more applicable in this case because both industrial districts have developed ports and port infrastructures.

Twenty-five years ago the riverine lands adjacent to the Fraser River downstream of New Westminster were

primarily classified as being vacant or used for agricultural or grazing purposes. In the intervening period more than 200 industrial establishments have located on these lands, employing approximately 10,000 persons. Similar patterns of industrial decentralization can be observed in most other North American metropolitan centres, although the presence of a ship canal capable of accommodating vessels up to 45,000 deadweight tonnes may have accelerated the process in this particular example. Indeed, proximity to the navigable Fraser River may lead one to hypothesize that marine transportation linkages have been the decisive locational factor in the industrialization of the Fraser River lands. In practice the process is much more complex, with transportation linkages being only one of the applicable variables. The aim, then, in this study is to identify and examine the relative importance of the four hypothesized locational factors noted previously, with respect to the conditions applicable at this specific site, and the metropolitan region of Vancouver in general.

If empirical testing indicates that suburban industry exhibits those characteristics and linkages expected of a capitalistic firm that is utilizing the factors of production to maximize profit by minimizing costs, then an improvement in the ability to predict industrial location and a better understanding of the underlying principles governing industrial processes will have been achieved. As well, the capability and potential for reducing the unknown factors involved in suburban industrial development will improve the

process of allocation of industrial land.

The objectives of this study will be fulfilled within the following five chapters. In chapter 2, a review of the more pertinent aspects of intrametropolitan location dynamics and port industrial activity will be presented. The research design and methodology to be employed in the ensuing chapters will form the basis of chapter 3. A detailed description and analysis of existing industry at the Fraser River site is presented in chapter 4. The foci of this investigation will be the documentation of existing interindustry commodity linkages of firms and consequent utilization of the transport infrastructure, and the determination of functional and structural similarities (or dissimilarities) between resident firms. In chapter 5 some of the more general indices, purportedly verifying a conceptual theory of decentralization, will be tested statistically. The conclusion, in chapter 6, will link the descriptive and industrial linkage profile with the indices of decentralization to ascertain any existing relationship.

CHAPTER 2
RESEARCH FRAMEWORK

There has been considerable decentralization of industrial activity in most Western metropolitan centres in the twentieth century. Although this phenomenon has varied in degree, its occurrence has been virtually universal in larger urban areas.

In this chapter a framework will be presented for the research conducted in the Greater Vancouver Regional District (GVRD). A brief summary of location theory and its applicability to decentralization will be followed by a discussion on early studies of decentralization and a review of the process in terms of four general site selection factors. These factors can be considered elements of a composite theory designed to explain the intrametropolitan movement of manufacturing. As well, in order to examine the influence of a suburban port on industrial decentralization, aspects affecting the relocation of modern port industry and facilities will also be considered.

The decentralization of industry, and specifically manufacturing, is only one part of the process of suburban industrial growth. This growth is composed collectively of the migration of firms from the urban core, elsewhere in the metropolis, and outside the metropolis, to the periphery; the birth of new firms in the suburbs; and the expansion of existing suburban

firms. Frequently, as Scott (1980) notes, the literature has incorrectly treated central city industrial decline and suburban growth as distinct and separate processes. In doing so, it has either failed to associate manufacturing change between the two areas or has inadequately attempted to explain the intra-metropolitan movement of manufacturing from either a suburban or central city perspective only. In addition, by treating industrial decentralization as an aggregate process, many analyses have failed to differentiate industries by sector. Factors of location affect the site selection process of different manufacturing sectors dissimilarly.

Some authors, including Hoover and Vernon (1959), Pred (1964), and Moses and Williamson (1967), date the origins of industrial decentralization to the late nineteenth century when the principal precondition for the dispersal of economic activity, increased efficiency of the urban transportation system, was achieved. Since that time, industrial activity has been decentralizing at an increasing rate. An empirical example of this phenomenon for one ten-year period is provided by Steed (1973) and shown on table 1. This trend, shown for Vancouver, has been verified repeatedly for most North American centres. In addition, the suburbanization of manufacturing has almost certainly intensified since 1965, the date shown in the example.

The demand maximizing approach to the explanation of industrial location developed by Lösch assumes that

TABLE 1

MANUFACTURING REDISTRIBUTION IN METROPOLITAN VANCOUVER, 1955 - 65

	1955	1965	Change
Core[a]			
No. of Plants	910	731	-179
% of Total	65.6	50.2	-15.4
Intermediate			
No. of Plants	340	533	+193
% of Total	24.5	36.6	+12.1
Peripheral			
No. of Plants	138	193	+55
% of Total	9.9	13.2	+3.3

SOURCE: Derived from Steed (1973, 244).

[a]Based on time-zone map for 1960: core equals 0-15 minute zone, intermediate equals 16-35 minute zone, peripheral equals 36-60 minute zone.

in a perfectly competitive situation, a firm's market area will assume hexagonal proportions. Based on the additional assumptions that population and resources are spatially homogeneous and transport costs are held constant, the firm will be located at the centre of its hexagonal market.

For several reasons, the utility of this theoretical framework is diminished when applied at the metropolitan scale. First, for a given level of output, demand, price of the product, and revenue can be viewed as locationally invariant across the metropolis. Price of the product is invariant at this scale, because differences in distribution costs for alternate metropolitan locations are small. As the volume of output increases, distribution cost differences decrease. In addition, for marketing and advertising purposes an average local price per unit, which includes transportation costs for all locally distributed products, masks differences in metropolitan demand that would have been created had variable distribution costs been evident.

Given this situation, one would expect a uniform distribution of industrial activity throughout the metropolis. However, site specific factors, including provision of services, proximity to transport corridors, and inertia, contribute to the creation of industrial nodes within the metropolis.

Classical location theory as applied to decentralization provides a more apt base upon which the modern

site selection process may be explained. Weberian location theory takes a cost minimization approach to explain plant location. In an attempt to formulate a 'pure' general theory of location (i.e., for all manufacturing at all times), Weber emphasized transport costs as the main general element in the site selection process. Accordingly, market/materials orientation would be determined with respect to the relative costs of transporting the firm's material inputs and outputs and the degree to which ubiquitous materials are used in the production process. Differentials in labour costs and agglomerative forces were portrayed as secondary factors that, if significant, could shift the location of the plant from the 'optimal' minimum transport cost site. Both transport and labour costs are considered general regional factors while agglomeration is considered a general local factor (Greenhut 1956; Webber 1972). Although, as with the Lõschian framework, Weber's (1929) 'Least Cost' explanation of plant location was designed for the national and regional decision-making scale, aspects of this theory may be more applicable at the local site selection scale.

Cost Minimization Theory and Industrial Decentralization

The importance accorded transport costs as an element in the locational process has decreased through time. Norcliffe (1975) described five factors responsible for this trend: structural changes in industry emphasizing high value - added activities, more efficient use of material inputs, improvements in the

quality of raw materials, increasing degree of substitutability between raw materials, and the development of transport technologies. As a result those industries with a low Material Index* are much more flexible with respect to metropolitan locations than they once were. As Yeates and Garner (1980, 366-367) note,

> ... many metropolitan markets can be served just as easily from sites at peripheral locations that are well served by circumferal transport networks. As a consequence, decentralization of manufacturing industries has been occurring at a fairly rapid rate as locations beyond the traditional central cluster become more feasible.

The preoccupation with transport costs (as opposed to site costs) as the factor in industrial decentralization was obviously warranted in the initial stages of the process. Efficient movement of material inputs and people enabled firms to serve the urban market adequately from a suburban site. Perhaps more importantly, the reduction in transport costs/unit broadened the market area of the industrial firm and created new non-local markets for production, thereby decreasing the importance of the local metropolis for consumption of manufactured production. It cannot, however, be considered as the overriding factor in modern industrial decentralization, but one element in the complex locational decision-making process. An explanation of

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*Material Index = $\frac{\text{weight of localized materials}}{\text{weight of finished product}}$

For elaboration consult Weber (1929, 59-61)

industrial decentralization that relies solely on transportation improvement lacks depth and comprehensiveness.

Weber postulates that labour costs will also influence the location of labour-intensive plants on a regional scale if the savings in labour costs at the alternate location exceed the additional transport costs. Although the validity of this statement has been questioned in the literature (Norcliffe 1975; Webber 1972), the applicability of wage rate differentials to the process of decentralization may be more useful as a locational factor at the metropolitan scale than at the regional or national one.

According to classical location theory, the role of agglomeration in the location of firms is as follows. Firms will attempt to minimize costs by a reduction in the size of physical linkages between themselves and their suppliers, consumers, and necessary services. Within the metropolis this would be reflected in a clustered pattern of industry at the city centre rather than a dispersed pattern. This location permits the firm to take advantage of external economies of scale. Neoclassical theory would also produce a central city cluster of industrial activity, but by maximizing access to customers rather than access to inputs and services.

Early Studies of Industrial Decentralization

A large number of studies have documented the

phenomenon of inner city industrial decline and concurrent suburban growth, but in most cases, they have suggested only local factors to account for the specific shifts in industrial location. Scott (1980) lists more than eighty examples in the literature that ascribe shifts in industrial location to a variety of 'push' and 'pull' factors.

The value and necessity of these studies is not being questioned. In order to develop a conceptual framework for decentralization, the nature and extent of the process must be understood. In that respect, these studies have served the purpose of providing a base from which theory can be formulated and verified. However, with few exceptions, there is little attempt in these studies to relate the process of decentralization to a basic underlying structure that would show these factors to be intermediary effects rather than causes of the process.

Capital Inputs and Decentralization

The process of decentralization and the factors purportedly affecting it may best be summarized by examining four interrelated elements: capital inputs, distribution costs, intrametropolitan wage rate variations, and agglomeration. Analyses of intraregional trade and the location of economic activity have consistently emphasized that the factors of production are perfectly mobile within the region and hence at the metropolitan scale as well. Lösch (1959), in an attempt to define an economic region, and Ohlin (1933),

in his explanation of trade, concur that capital costs do not vary significantly within the metropolis. Proceeding from this, David Smith (1971) separates capital into financial and fixed capital. Financial capital, consisting of investment funds, is that which Smith considers mobile, and therefore spatially invariant at the metropolitan scale (Smith 1971, 38). The main determinant of the cost of financial capital, interest rates, varies minimally by metropolitan location. However, fixed capital inputs, composed of a much broader range of items, do vary in cost at alternate metropolitan locations.

The most important fixed capital inputs for the modern manufacturing firm are the contract rent and cost of commodities, machinery, and buildings. Contract rent is defined as "...the actual payment tenants make to others for the use of their land or property." (Lloyd and Dicken 1972, 16).* Various geographers have discovered that there exists a spatial relationship between industrial land costs within the metropolis and distance from the city centre for most major North American urban centres (Hamer 1973; Field and Kerr 1968; Clark 1967; Smith 1971). Generally, the resultant pattern is one of declining industrial land prices as distance from the Central Business District increases. Although distorted by levels of accessibility, it is expected that the wide variations in this important fixed capital cost item would have a

*In subsequent references, contract rent may also be referred to as land cost(s), and land price(s).

significant effect upon the location of industrial activity.

The plant and equipment within the plant often combine to form an important part of fixed capital costs, particularly during the initial stage of production or in subsequent expansion. This importance has been achieved as a result of increased inner city land costs and declining site availability (primarily attributable to land-use competition, the use of land-extensive production techniques, and the increasing propensity for firms to substitute capital for labour during production) (Smith 1971, 52).

As the plant and equipment of central city manufacturers depreciates in value, or the decision is made to expand production, the firm is faced with a dilemma regarding future capital investment. They have the option of continued intensive utilization of inefficient multi-storey production techniques at expensive central city sites or relocation to a larger suburban site in order to capitalize on 'modern' single-storey assembly line production techniques. Rarely is the actual choice as distinct and simple as that presented, or the applicability to the entire range of manufacturing activities as invariable (i.e., dependent upon the degree of capital/labour intensity of the specific industry). However, regardless of the industry's degree of dependence on capital as a factor input, any rational expenditure will be made with the goal of maximizing profit and/or production. The suburban site will, in most cases, yield greater utility in terms of

return on investment from machinery and is more suited to existing land-extensive production techniques than is the central city site.

Commodity capital can be described as those fixed capital investments in material inputs and product inventory that are maintained by the firm. Those firms that minimize their investment in materials or products by dealing on a 'per job' basis (e.g., commercial printers) or by using and producing low mass/volume items (e.g., jewellery manufacturers), do not require extensive storage or warehouse space. By utilizing the land intensively, they can bid more competitively for central city industrial land. Conversely, firms that require/produce bulky inputs/products (e.g., the concrete products industry) or stockpile large quantities of materials to save on transport costs (e.g., petroleum refineries) are extensive land users. Inexpensive land for the storage of these commodities is essential to the economical operation of the firm. Hence, a suburban site is more advantageous for those activities with large commodity capital investments.

An example of the role of commodity capital investments affecting industrial decentralization is provided by Norcliffe (1980a, 12) albeit in a slightly different context. The Hearne coal-fired generating plant in Toronto could accommodate the necessary expansion of facilities on its fifty-acre central city site but could not provide space for the additional stockpiles of coal required to fuel it. As a result, the Hearne station made more intensive use of existing

land resources by converting to natural gas consumption, and to serve future demand, a new generating station was constructed on a greenfield site at Lakeview, 24 kilometres west of the city centre.

Fixed capital inputs have a broad impact upon the intraurban movement of manufacturing. To this point, however, the firm has been considered in isolation from its network of suppliers and consumers. Realistically, a complementary set of distributional costs dealing with the assemblage of material inputs and shipment of outputs must also be considered.

Distribution Costs and Industrial Decentralization

There are two major interrelated components of the firm's distribution costs affecting the movement of manufacturing within the metropolis: the firm's interindustrial linkages and the transport costs associated with those linkages. Scott (1980, 6) remarks that there are two costs incurred in the maintenance of the material linkages of a firm at the metropolitan scale: the direct cost of transportation of the materials and the "...indirect overhead cost related to the number of man hours involved in negotiating such matters as price, quality, design specifications, and so on."

As the quantity of material inputs increases the direct transport costs per unit decreases, as does the overhead cost associated with these linkages. Therefore, a large firm, with standardized inputs and established linkages has more flexibility in choice of

location. Conversely, a small manufacturer typically has unstandardized inputs, variable linkages in terms of quantity and source, and requires frequent contact with suppliers/customers (i.e., overhead costs are high). Based on these criteria, a distinction can be made with respect to the type of firm that is most able to decentralize. Those firms with standardized linkages are more able to withstand an increase in distance of the material linkages and disperse from the agglomeration of industries found at the city centre.

Although the distribution costs of a manufacturer will vary significantly over its range of national or international markets, therefore affecting demand spatially, within the local metropolis the differences in distribution costs (especially for large-scale manufacturers) are minimal. As Hamer states,

> ...the increasing reliance by firms on ubiquitous highway systems makes distribution costs (and therefore delivered price) differentials very small within a given urban area market... at different sites within the urban area, the delivered price of the final good to customers within that area would be very close to the local factory price. (Hamer 1973, 23)

Because distribution costs have decreased in importance as an element in the relocation of industry, the modern urban manufacturer is becoming locationally more footloose. This trend is reflected in two ways: the manufacturer serving the local metropolitan market is not confined to an urban location as close to that market, and intermediate industries are less affected by the metropolitan location of supplying and consuming industries. It is noted that increasing energy costs

in the past decade, combined with the likelihood of future increases, may restrict the magnitude of these effects.

Wages and Industrial Decentralization

Wage rate differences within the metropolis have been either overlooked or discounted by most authors as a factor in the location of a firm. This lack of attention may in part be due to the premise that accessibility to the metropolitan labour market is homogeneous, making wage rates invariant. There are, however, a growing number of geographers suggesting that relative wage rates do vary spatially within the metropolis and that this variation can have a profound effect upon industrial location (Goldner 1955; Segal 1960; Lever 1975; Moffitt 1977; Scott 1979).

The importance of wages as an element of total operating costs varies with the industry and the proportions of capital and labour used in production. However, for all manufacturing activities in metropolitan New York, Segal indicates that, "...labour costs are roughly 15 times as large as space costs and 21 times as large as local and state taxes" (Segal 1960, 6). It is hypothesized then that a variation in metropolitan wage rates may play an important role in the location of industry.

Early studies on the effects of wage rate differences on industrial location tended to show that wages decreased as distance from city centre increased (Rees and Shultz 1970; Lever 1975). The rationale for this

relationship appeared to be that labour costs are directly related to the distance from the labour surplus to the labour deficit areas. As such, the central city employer would have to pay a wage premium to attract employees from the peripheral residential areas.

These analyses are based on the premise that intraurban wage rate differentials between the city and suburbs are the result of a combination of two processes, industrial decentralization and population decentralization. Industrial decentralization leads to lower labour demand in the city and consequently lower central city wages. Population decentralization provides a lower central city labour supply and hence higher central city wages. Moffitt (1977) concludes that the variation in wage rates is a function of the relative strength of these two processes.

Empirical evidence has provided a variety of apparently conflicting results with respect to wage rate variation within the metropolis. As noted, Rees and Shultz (1970) and, to a less reliable degree, Lever (1975) have concluded that wage rates decline systematically from the city centre to the periphery. Conversely, Hoover and Vernon (1959) and, in an associated study, Segal (1960) determined that over a 55-year span in the New York Metropolitan Region central city wages declined from being greater than peripheral wages in 1899 to being substantially less (approximately seventeen to twenty per cent) than peripheral manufacturing wages by 1954. A more recent study by Scott (1979)

reiterates this direct relationship between labour costs and distance from the city centre, as presented in table 2.

One rationalization for this relationship is that, despite recent population decentralization, there remains a labour surplus at or near the city centre. In addition, the city centre remains the most accessible location for the urban labour force as a whole. This surplus labour supply tends to deflate local wage rates. Peripheral manufacturers, faced with competition for the available labour supply, must pay a wage premium to attract employees to their comparatively less accessible sites.

Several arguments have been raised that question the significance of wage rate differentials. The main objections prescribe that differences in prevailing wage rates are attributable to either the industrial or occupational mix at a location or the relative skill level of an individual within the specific occupation. Although these objections deserve merit, their influence is diminished when one considers the following.

Wonnacott (1963), in a study comparing manufacturing costs within the United States on a regional scale, standardized the industrial mix between regions in order to determine whether wage rate variations persisted. He concluded that the particular industrial mix of a region was not a strong determinant of the prevailing wage rate. These results raise doubts concerning the importance of industrial mix, despite

TABLE 2

INDUSTRIAL WAGES AS A PERCENTAGE OF CENTRAL CITY WAGES IN METROPOLITAN TORONTO, 1972

Zone[a]	Production Workers	Administrative Employees	Weighted Total
I	100	100	100
II	104.9	101.0	105.6
III	118.8	107.4	115.2
IV	98.9	104.2	102.2

SOURCE: Scott (1979, 29)

[a]As a rough estimate, zone I = 0-10 km from Central Business District, zone II = 10-22 km from C.B.D., zone III = 22-38 km from C.B.D., zone IV = 38-54 km from C.B.D.

the fact that the analysis was conducted at the regional rather than the metropolitan scale.

The relative level of skill attained by employees in different areas of the metropolis may pose a potentially more serious problem. Because levels of skill are difficult to measure, then effects upon wage rates are also hard to assess. Presumably, a concentration of lower skilled workers in a particular occupation at a specific site will command a lower average pay.

Problems arising from these objections can be minimized if several methodological precautions are taken.

1. Wherever possible, disaggregate occupational categories prior to analysis of wage rate differences.

2. Obtain wage data that reduce differences attributable to skill level (e.g., average starting salaries within an occupational class)

In addition, it has been suggested that, with unionization and collective bargaining agreements, the potential for wage rate variation on a metropolitan scale is restricted. It has been shown, however, that although unionization can affect the lower limits to wages, the upper limits to wage rates are relatively unaffected (Mackay et al. 1971). Also, if the upward pressure on wage rates due to unionization becomes

unbearable, those companies/activities being affected would seek out non-unionized locations outside the metropolis.

A final qualification concerning wage rate differentials deals with a factor previously noted with respect to material flows: the reduction in transportation costs (or in this context, commuting costs). As commuting costs decrease (in terms of monetary cost or time), the labour market range of a firm increases. Although this phenomenon has surely mitigated city-suburb wage differences, studies continue to indicate that wage rates remain directly correlated with distance-to-work (Rees and Schultz 1970). In addition, although it has been noted that transport costs on the whole have decreased in importance, there exists a difference in the degree to which these costs have diminished between goods movement and people movement. Törnqvist states that, "Thus whereas distance has practically ceased to be an obstacle to freight transport, its constraint on the transit of persons is, and will remain, substantial" (Törnqvist 1969, 99).

Empirical evidence on spatial wage rate differentials seems to suffer from generality in either industrial or occupational breakdown. A finer measurement of the wage rate gradient may reveal that for certain occupations or activities the central core has a labour cost advantage over the periphery, and vice versa. Taking this premise to its logical conclusion, those industries relying upon labour as an important element of total production costs would tend to gravitate to

those locations where the applicable wage rates are lowest: the central core. Conversely, a decentralizing force is acting upon those activities whose labour inputs form a small portion of total production costs. These capital-intensive industries are less affected by existing wage rate differentials but, as has been noted, their location is primarily affected by variation in fixed capital cost items (i.e., land costs being the major component). This concept forms a fundamental part of Scott's (1980) conceptual analysis of intraurban industrial movement that combines aspects of location theory (as reflected by the development of a 'growth theory' of industry) with the theory of production of the firm. An elaboration of this analysis will follow shortly.

Agglomeration and Industrial Decentralization

Agglomeration economies and associated economies of scale have long been recognized as important components of the locational model (Struyk and James 1975). The most common agglomerative effects are those cost savings that would accrue to a firm by a reduction in the physical distances between it and, primarily, its suppliers and customers. As well, proximity to printers, warehousing, banks, restaurants, service stations, and a range of other activities enhance the attractiveness of an existing industrial area (traditionally at or near the city centre) for future industrial expansion.

These external economies of scale (i.e., the minimization of production costs by the provision of services from sources external to the plant) are not applicable to all activities to the same degree. As noted earlier in the context of linkages, those firms that are relatively small require frequent contact with suppliers/customers, and utilize unstandardized inputs/outputs also use external economies of scale to the greatest advantage.

Struyk and James (1975) provide strong evidence that the industrial cluster at the city centre eventually reaches a critical point wherein deglomerative factors exceed the benefits accrued from the positive aspects of agglomeration. These deglomerative factors (including high land costs from increased land-use competition, transportation congestion, etc.) tend to make suburban locations more attractive to firms.

When related to the reduction in freight transport costs within the metropolis, agglomeration and decentralization take on added dimensions. The resultant effect has been a weakening of agglomeration economies. As well, the creation of preplanned suburban industrial parks with built-in service linkages have produced peripheral nodes of agglomeration (Lever 1975). The combination of these factors (i.e., transport improvements, suburban industrial parks, and city centre deglomerative forces) have tended to flatten the direct agglomeration economy-distance gradient described by Alao (1974).

These changes in the role of agglomeration in metropolitan manufacturing are also emphasized by Hamer.

> In other words, the agglomerative economies associated with the nineteenth century central city are now being shared by a far larger zone, as the process of suburbanization yields an area of relatively high density conducive to such positive externalities. Suburban areas not only possess the basic infrastructure (streets, water mains, sewerage facilities) but also a concentration of manufacturing firms which allows, to a large degree, a relatively costless interaction of firms with local intermediate requirements. (Hamer 1973, 25)

A Theory of Intrametropolitan Manufacturing Migration

Scott (1979, 1980) builds upon the 'incubator hypothesis' originally developed by Hoover and Vernon (1959) by presenting a conceptual theory of intraurban manufacturing migration that accommodates the numerous empirical analyses of the process. Hoover and Vernon proposed that, because the risk factor involved in starting a business is high and available capital is difficult to acquire, new firms will attempt to minimize their costs by maximizing their use of external economies of scale. The prime location to maximize these external economies is the central industrial district. Following this 'incubation period' for those few firms that remain in business are the product cycle and hierarchical filtering stages. Together they form an overall 'growth theory' describing the life of a firm. As a firm grows, its ability to substitute internally those functions that were previously received externally increases.

By internalizing these economies of scale the firm is allowed more locational freedom. Combined with several other characteristics of a firm's growth, this constitutes the product cycle stage of development. Erickson and Leinbach (1979) indicate that the growth in production of the firm leads to the generation of greater and more standardized inputs/outputs and consequently an increase in space requirements. Given this situation the hierarchical filtering stage involves the movement of these growing firms from their nurtured environment in the city centre to non-central locations (Erickson 1976).

Scott (1980) observes that, although growth theory includes some of the key aspects of a dynamic interpretation of intrametropolitan manufacturing location, it fails to incorporate fully all aspects of the capitalist production system within the theory of location. The most basic aspect of this theory is that a firm will attempt to employ the factors of production (capital and labour) in quantities that will maximize profit. He hypothesizes that capital and labour costs vary across the metropolis, with capital costs (including land, plant, equipment, and commodity capital) being generally greater at the core than at the periphery, and labour costs (as reflected by wage rates) increasing from the core to the periphery. Labour-intensive firms will have a tendency to cluster at the urban core where accessibility to the local metropolitan market is maximized and capital-intensive firms will gravitate to peripheral locations where capital costs can be minimized.

The dynamic aspect of the hypothesis, and hence the applicability to decentralization, occurs as a result of substitution of capital for labour during the firm's growth. In accordance with the growth theory, the central core is an ideal location for the birth and initial growth of a firm (Steed 1973). As an establishment grows in size, increased production is usually achieved by the substitution of labour by capital. Consequently, at the same time as a firm is internalizing economies of scale, thereby becoming less dependent on inner city linkages and related agglomerative effects, it is utilizing the labour market cost advantages at the city centre less effectively by substituting its labour inputs for capital inputs. The impetus for decentralization occurs as a result of technological innovations in the production process and an accompanying injection of greater amounts of capital so that these innovations can be adopted.

With industrial decentralization labour costs increase, reflecting the labour deficit situation created at peripheral areas. These decentralizing firms, being capital intensive in nature, can more easily withstand the higher suburban labour costs. However, resident labour-intensive manufacturers at these peripheral sites find it increasingly difficult to compete for a labour force, and, over time, will gravitate to the city centre to take advantage of lower cost labour.

In order to substantiate this process, Lichtenburg (1960) and Tulpule (1969) provide evidence showing that

in both New York and London, those firms decentralizing from the core were also those achieving the highest levels of capital intensification. To lend credence to the validity of the reciprocal component of the theory, Lichtenburg (1960), Saussy (1972), and Struyk and James (1975) indicate that in recent years labour-intensive activities have had a tendency to centralize.

Distribution costs play an important role in this process, because not only has their reduction provided for a suburban alternative in location, but also because capital-intensive suburban firms have commodity linkages that differ from those common to labour-intensive core firms. Suburban firms typically have larger quantities of material inputs and the linkage pattern is more dispersed. The larger volume of inputs reduces the transport cost per unit shipped and enables more distant suppliers to compete with local suppliers.

Tornqvist (1969) presents another distinguishing feature in the linkage patterns of central city and suburban manufacturing: the proportion of information (i.e., administrative) linkages to commodity (i.e., material) linkages of a firm. Information linkages, involving frequent face-to-face contact, are predominantly associated with centralized firms. Conversely, firms at suburban locations place greater emphasis upon commodity linkages. In a dynamic context, the decreasing importance of information linkages during a firm's growth permits the suburban migration of manufacturing. As has been noted, some activities, regardless of their size, continue to

exhibit a large proportion of information linkages. For these activities, a central market location remains essential.

There are several factors indicating that this explanation of manufacturing location has only temporary applicability. A continued decentralization of the population from central city locations will reduce the labour surplus advantage held at this location. However, despite the suburbanization of population the city centre will remain the most accessible location. As well, the type of labour that is most commonly employed in labour-intensive central core manufacturing is constantly being maintained in the larger urban centres by the continued immigration of new pools of low wage, unorganized migrants.

Capital-intensive firms will continue to maximize the utility of fixed capital inputs through land-extensive production techniques as long as these inputs, employed in suburban locations, can be used more effectively at suburban sites than at central city sites. The most probable alternative for capital-intensive firms, given a scenario of increasing suburban land costs relative to city land costs, is a new round of industrial decentralization to more distant sites in order to maximize returns from capital inputs.

Port Industry

Port industries are not immune to the processes described above. Changing port conditions have played

a part in the migration of waterfront industry from traditional port sites. The following section will outline those forces affecting the decentralization of port industry and port facilities to alternate waterfront sites within the framework already provided to explain the intrametropolitan relocation of industry in general.

A port is defined in Webster's Third Edition Dictionary (1971) as "...the starting point or the destination of a voyage: a place to or from which goods may be shipped..." As such, ports have had an agglomerative force, attracting people and economic activities. Many Canadian cities (including Vancouver) owe, in part, their origin and initial development to the advantages of their particular waterfront location in terms of shelter and protection. An indication of the initial importance of these water/land interface locations on subsequent urban growth is provided by Moss (1976). He states that, "of the 20 largest cities in this nation [United States], 17 are situated at the intersection of a navigable body of water with land." (Moss 1976, 223).

Historically, a mutual dependency existed between the port and port city for the provision and shipment of trade goods, thus requiring efficient access between the urban core and the waterfront. The importance placed upon the reduction in size of transport linkages accounts for the focus of central city activity on the port. Cargo handling and existing port industries were quite labour- and land-intensive activities. Labour

intensity was reflected in the manual movement and storage of cargo, and the functional structure of port manufacturing (e.g., rope making, sugar refining, and rum distilling) (Pred 1964, 166). The use of multi-storey warehousing and finger pier docking facilities illustrates the land-intensive aspects of port industry.

Slack (1975) and later Norcliffe (1980a) identify three types of port-related industry. These are loosely described as (1) those establishments that provide a port- or marine-related service (e.g., stevedoring, ship repair, steamship companies, tugging and dredging operations), (2) those facilitating the actual transfer of goods at the port (e.g., terminal owners/operators, freight carriers), and (3) those that use the cargo imports and exports directly in production. This latter group can be subdivided into those solely involved in the storage and distribution of materials (e.g., grain and coal terminals) and those adding value through manufacturing.

Because of the existing agglomerative forces and labour supply, port industries have traditionally clustered around the central port location rather than spreading along the waterfront away from the central city (Bird 1973). Changes in the nature of cargo handling and industrial production, involving as a primary component labour-to-capital substitution noted previously, have resulted in a spatial redistribution of port facilities and port industry.

Norcliffe (1980a) outlines four major processes influencing the decentralization of port industry.

1. Capital intensification and job elimination by port industries;
2. Greater space consumption by port industries;
3. Land-use competition within port areas;
4. The growth, in port areas, of industries not directly related to the port. (Norcliffe 1980a, 1).

To these should be added a fifth process: the increasing emphasis placed upon truck transportation and the resultant deterioration of rail service as elements of the modal structure of port industry.

Capital Intensification and Port Industry

As has occurred with most non-port industry, there has been an increasing tendency amongst port industries to substitute capital for labour inputs in an attempt to maximize productivity. This capital intensification has been reflected, in part, by changing cargo-handling technologies. For port operators, the basic objective has been to decrease operating costs by shortening vessel turnaround time at port. Port time is the most unproductive and costly element in vessel operation. This is emphasized by Parrot, who stated in 1966 that "...50% of a vessel's operating costs, or up to 50% depending on the trade, are accounted for by the loading and discharging costs." (Parrot 1966, 42).

Canadian domestic and overseas shipping trade consists, to a large degree, of liquid and dry bulk cargo. In 1977, 71.5 per cent of total overseas traffic loaded at Canadian ports consisted of bulk goods (85.7 of 119.8 million tonnes). Dramatic improvements in bulk cargo-handling techniques, subsequently causing job elimination, have occurred as a result of the capital intensification of port activities. Dry bulk shipping improvements include conveyor capacity increases, computer-directed bottom and side rail car unloading, and slurry, suction, and pneumatic pumping of solids through pipelines in a solid/liquid mixture (Frankel 1973, 12-15). Liquid bulk transfer operations using ship-to-shore pipeline hookups, and automatic controls to determine the optimum flow of liquids through pipelines to tankers, reduce vessel port time and the amount of labour required.

The Robert Banks coal terminal, located 33 kilometres south of Vancouver, provides an excellent example of improvements in bulk-handling techniques resulting in job elimination. Located at a rail-serviced deepwater site, the terminal consists of a 22-hectare pad connected to the shoreline by a five-kilometre causeway. Unit train rail cars arrive at the terminal from interior British Columbia coal fields, are laded onto supertankers by automated control mechanisms, and return to the coal fields in a continuous cycle. There are approximately five employees on site to facilitate the movement of 6,544,286 metric tonnes of coal per year (1976).

General cargo-handling techniques have undergone as rapid a capital intensification as have bulk cargo-handling methods. From a highly labour-intensive system using dollies, cranes, and carts, the need to decrease port loading/unloading time has been reflected in the development of palletization, roll-on/roll-off ships (accommodating truck trailers for efficient transfer of goods between ship and highway), and containerization. Containerization, and the associated movement of goods with container docking facilities, have contributed to the largest extent in limiting the labour component of general cargo handling at the port.

Wallace (1975, 434) defined containerization as the application of mass production techniques to freight shipment through the mechanized handling of a box of standard dimensions in a controlled system of intramodal transportation. As such, containers can be transferred efficiently at break bulk points via truck, rail, or ship without disturbing the contents. The application of this system of general cargo movements involves large amounts of capital. Halifax's first container terminal (Halterm) was constructed in 1970 at a cost of $15,000,000. Brunterm, at St. John, New Brunswick cost $40,000,000 upon completion in 1975 (Wallace 1975, 440).

Two examples will help to illustrate the degree to which capital has replaced labour at modern port facilities. Ross (1970), quoted by Wallace (1975), estimates that to discharge and load 11,000 tons of cargo aboard a conventional ship would require 10,584 man-

hours. This same cargo, containerized, would use only 546 man-hours, or 5.15 per cent of the former labour time. The second example, once again drawn from the Maritimes, is presented by Dougall (1974) and revised by Norcliffe (1980a). By relating the difference in waterfront employment at Halifax between 1971 and 1976 to the change in total general cargo tonnage shipped (break bulk and container), Dougall estimates that containerization has resulted in a threefold increase in labour productivity. Norcliffe reevaluates this analysis and concludes that Dougall has underestimated the increase in labour productivity. Instead, he states that, "...labour productivity increases roughly tenfold with containerization." (Norcliffe 1980a, 8).

A port location satisfies the needs of the two major types of port manufacturers. The first has substantial shipments of bulk raw materials and/or final products (e.g., iron and steel industries, wood and pulp industries). A second type of manufacturer requires the water itself as a medium in production, either for cooling, processing, or waste abatement (e.g., chemical industries, concrete industries). In the past, when the labour component of these activities was a significant part of total costs, a location at the waterfront, yet accessible to the central city labour supply, was a necessity. However, the adoption of land-extensive production techniques and the mechanization of production, combined with the other general factors noted previously affecting all metropolitan manufacturing, have all acted to decentralize these firms to suburban waterfront sites.

With respect to Scott's hypothesis then, the decreasing labour sensitivity of port-handling operations and port industry have lifted the restrictions placed upon them to seek out the labour surplus central city port location. The increasingly efficient use of fixed capital inputs by port-related activities is reflected spatially by their changing land requirements as well.

Land Requirements of Port Industry

Containerization, and the necessity to decrease ship turnaround time, have resulted in increasing land requirements in the form of backup space for port facilities. General cargo-loading docks must have at their disposal space for the assemblage and temporary storage of cargo to be loaded and unloaded from large capacity ocean-going vessels. Although logistical transportation planning has alleviated bottlenecks created by extended storage of goods at the waterfront, the absolute demand for space created by the use of land-extensive storage and distribution practices to increase facility efficiency has exceeded the increased efficiency of cargo-handling operations.

Bulk cargo terminal operations generally involve no more than the temporary storage and distribution of materials. However, because of the nature of materials being handled, they also require a considerable amount of land. Because these cargoes command a low value per unit weight, the ability of these industries to compete with more intensive land users for waterfront lands has

been reduced and decentralized waterfront lands have become an attractive economic alternative. The Roberts Bank outerport is an example of one of these alternatives.

Another factor promoting the decentralization of bulk cargo terminals is that, in many cases, their location is not strongly influenced by the local market. Grain, as well as coal, sulphur, potash, and other mineral exports are assembled from a large hinterland. As long as rail and port facilities are maintained, a minor shift in the point of destination will have little effect on assembly costs.

The economies of scale associated with the use of larger capacity vessels has created and augmented this requirement for large plots of waterfront land. Table 3 confirms this trend towards larger capacity ocean-going vessels. The implications of this trend towards larger vessels upon port infrastructure requirements and decentralization are reflected in the following ways. The first effect of increased capacity vessels (especially general cargo ships) is the need for greater backup space to accommodate the cargo being loaded and unloaded. This requirement has led to the decentralization of port facilities and port-related manufacturing in Montreal (Slack 1975), Vancouver (Steed 1973), Antwerp (Bird 1967), Rotterdam, Southampton, and LeHavre, amongst others. In addition to having greater amounts of inexpensive backup space, many decentralized sites offer less prohibitive draft restrictions than do the traditional port sites. Although several authors (Robinson 1971; Layton 1978;

TABLE 3

DISTRIBUTION OF WORLD SHIPPING FLEET BY SIZE

Gross Tonnage	1969		1979	
	No. of Ships	%	No. of Ships	%
6,000-29,999	10,009	90.26	11,085	80.10
30,000 - 59,999	943	8.50	1,435	10.37
60,000 - 99,999	86	0.78	604	4.36
100,000	51	0.46	715	5.17
TOTAL	11,089	100.00	13,839	100.00

NOTE: Derived from Lloyd's Register of Shipping, Statistical Tables (1969, 1979); vessel types consist of general cargo, passenger, oil tanker, and ore and other bulk carriers.

Bird 1962) maintain that draft restrictions at traditional berthing facilities are providing the major impetus for port relocation, Norcliffe (1980a) insists that this is secondary to, and coincident with, the demand for larger sites.

Consistent with the capital-labour substitution hypothesis then, is this related process of port facilities and manufacturing maximizing their capital inputs by adopting land-extensive production practices at suburban locations. The high cost associated with central city waterfront land, in comparison to suburban waterfront land, limits the future expansion of port manufacturing at central city sites. The major cause of these high land costs relates directly to the third process affecting decentralization, the competition for waterfront land with non-industrial land users.

Waterfront Land-Use Competition

Traditionally ports were discrete nodes at the heart of central city activity, yet separated from the city by rail lines, fences and their reputations as crime-ridden sectors of the city. For both safety and security, citizens were discouraged from visiting the waterfront. Recently, however, this prevailing view of the port as an area only for industry has been changing. There has been a concerted effort in many North American waterfront cities to redevelop the port as an integrated part of the city for the use of people. A broad range of these redevelopment efforts are noted by Merrens (1980) and a definitive example of

the current sentiment is provided by the port of Montreal harbour authorities.

> The objective of this undertaking [demolition of facilities at old port site] is to add to the charm and attraction of the old city by converting an outmoded harbour area into green space and by restoring to old Montreal the window on the river which was part of its birthright before transit sheds and grain elevators blocked the view and fences and rail lines prevented access to the river. (Montreal Port Authority 1978, 6)

This type of attitude has resulted in increased competition for available waterfront land at the city centre with recreational, residential, and commercial land users. Competition with these comparatively more land-intensive activities has increased the cost of waterfront land. In many cases, the mechanism used to achieve this 'people-place' image has been municipal political pressure applied through zoning bylaw changes. As a result, manufacturers have often been discouraged from remaining or expanding at their central city sites.

Non-Port Industrial Competition

The fourth process affecting the redistribution of port industry noted by Norcliffe (1980a) is an elaboration of those aspects of Scott's (1980) hypothesis dealing with the inherent advantages of a central city location for certain types of industry, notably those activities characterized as being labour-intensive and non-port oriented. Because the port industrial area

does not normally command the highest city land prices but is still accessible to an abundant supply of unskilled labour, labour-intensive non-port activities can displace more capital-intensive port-related activities. As well as being better able to capitalize on the labour supply advantages of a central city location, non-port industries serving the local market exclusively (e.g., courier services) have a competitive advantage for available land over port-related industries whose linkages are not exclusively oriented towards the local market.

The existence of an ample supply of waterfront industrial land does not necessarily guarantee the growth of water-oriented industry at the central port. For example, in Toronto almost 600 acres of industrial land is available for development at the port. Despite this supply, port authorities are finding it difficult to lease or sell to port-using activities. In order to achieve some return on investment, non-port using industry is being allowed to locate on watefront land better suited for port industry. The most notable characteristics of these new industries are their higher degrees of labour intensity, and their strong local market orientation (Ainlay 1978).

Truck Transportation and Port Industry

Historically, ports generated agglomeration economies because a location at a break bulk point minimized total transport costs for the manufacturer. The reduction in transport costs as a result of expressway

development, more reliable and economical truck transportation, and improvements in cargo-shipping technology have decreased the importance accorded the port location.

An improved expressway system has reduced the transport cost of the intermediate travel link from the port to the manufacturer. Consequently, land-based transport costs incurred in maintaining existing linkages are not so prohibitive as to prevent the decentralization of port users to suburban waterfront location. In addition, the unitization of cargo in containers or trailers facilitates the movement of materials by truck. Although the optimal location before land costs are considered remains the break bulk point at the central city port, higher central port land costs shift the optimal location to a suburban site.

Slack (1975) concurs with this statement and elaborates by noting that the growing significance of trucking emphasizes the importance of road access to ports. For example, those container terminals that supply a large proportion of freight to the local hinterland require access to expressways in order to take advantage of the economies of scale associated with this shipping technology. The principal scale advantage is in the efficient movement of goods from port to hinterland destination.* The suburban port is

*For those ports located in isolation from their network of origin and destination points, access to railways assumes more importance than access to expressways.

better situated to take advantage of proximity to highway transportation than is the central city port.

The growing importance of truck transportation has had another effect which has indirectly contributed to a decentralization of port manufacturing. As shipping lines and manufacturers shift increasingly to truck transport, port rail service declines and freight rates increase. The declining service/increasing rates further exacerbate the problem, contributing to a faster shift to truck transport. Truck transport advantages at peripheral port sites become increasingly important to the firm as its modal structure changes.

Summary

The study of industrial decentralization has progressed from the descriptive localized scale to the state where a general explanation can be formulated, incorporating the theory of location and the theory of production of the capitalist firm at a micro (metropolitan) scale. Industries use different proportions of capital and labour in production. Those industries using proportionately more labour in production are going to gravitate to central city locations in order to take advantage of the resident labour surplus and lower labour costs. Conversely, industries using proportionately greater capital inputs will be attracted to suburban locations where investment in capital, in its many forms, can be used most efficiently. The general factors of capital costs, labour costs, standardization of distribution costs,

and agglomeration economies are seen then to be essential elements of this process. Rather than applying only to a specific case, the role of these factors can be related generally to industrial decentralization.

Port industry and facilities have been affected by the same processes as non-port industry. Improvements in productivity and efficiency have occurred as a result of the substitution of capital for labour in production. This capital intensification of port activities, as reflected in equipment investment and space requirements, has contributed to their decentralization to suburban waterfront sites. This has occurred because the labour surplus at or near the city centre has decreased in importance as a locational factor binding increasingly capital-intensive port industry to their central waterfront sites. The following chapters will determine the applicability of the processes outlined.

CHAPTER 3

RESEARCH SETTING AND METHODOLOGY

The focus of this research is to determine the influence of a number of general factors on the decentralization of industry in a metropolis and, at a more specific level, the effect of an industrially zoned suburban port upon the intrametropolitan movement of port activity. In this chapter the methodology involved in the preparation of the research and data collection will be reviewed. An examination of the methodology employed includes delimitation of the study area, presentation of various data sources, and an introduction to, and reasoning for, the sampling and survey methods used. This methodological review is preceded by a brief description of Vancouver that presents the more salient features of the metropolitan industrial and port structures.

Industry and Metropolitan Vancouver

The Greater Vancouver Regional District (see figure 1) consists of seventeen communities and had a population in 1976 of 1,085,000 (Vancouver, City Planning Dept. 1977, 3.16). This makes the metropolis the third largest in Canada. In addition, the three ports within the GVRD municipal boundaries (Van couver, Fraser River North Arm, and Fraser River Main Arm) combine to handle the largest amount of waterborne cargo of any Canadian port. Various aspects of the industrial structure of the metropolis have been investigated by a number of people including Hardwick (1971,

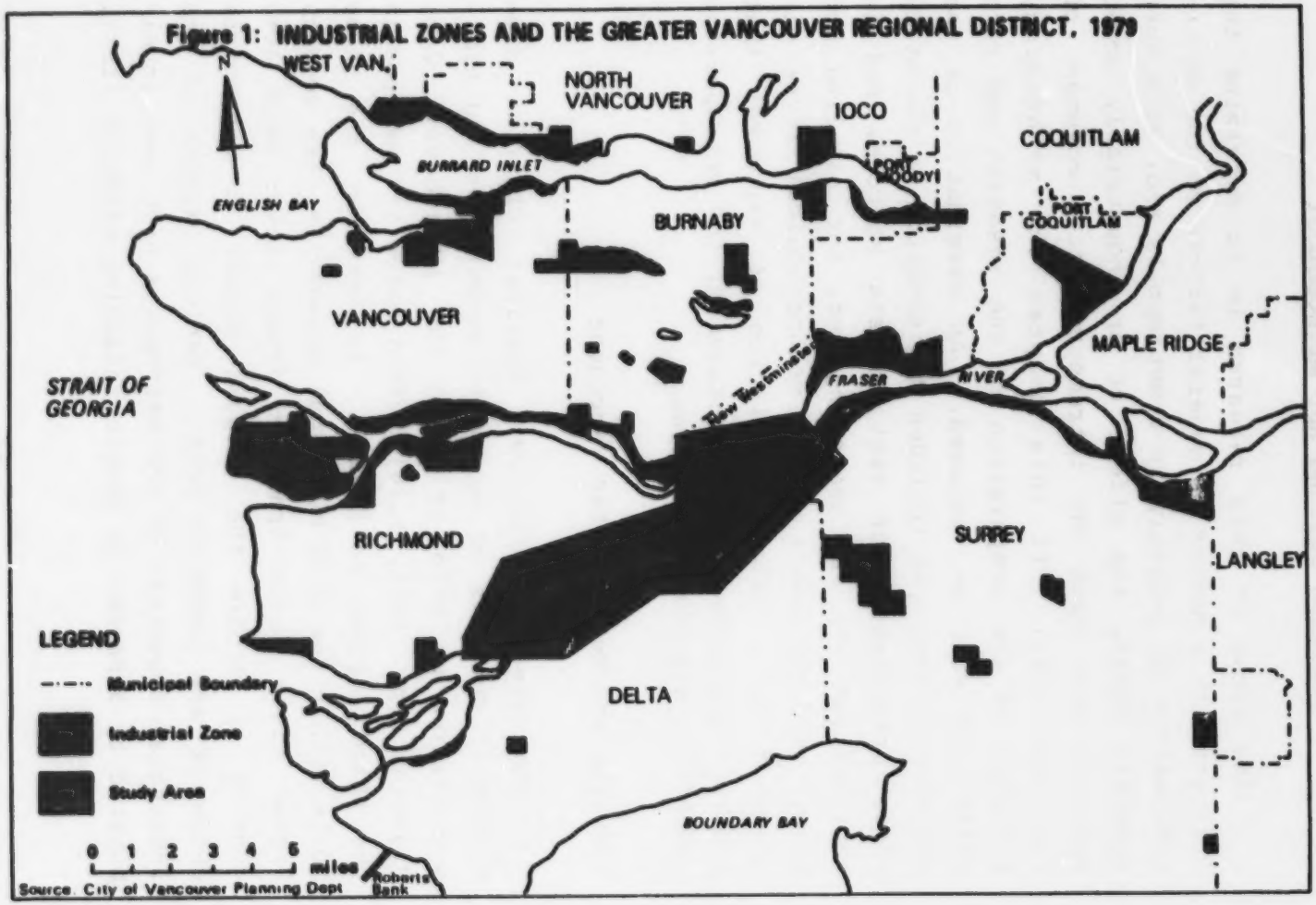


Figure 1: INDUSTRIAL ZONES AND THE GREATER VANCOUVER REGIONAL DISTRICT, 1979
N
WEST VAN.
NORTH VANCOUVER
IOCO
COQUITLAM
BURRARD INLET
PORT MOODY
ENGLISH BAY
BURNABY
PORT COQUITLAM
VANCOUVER
MAPLE RIDGE
STRAIT OF GEORGIA
New Westminster
FRASER
RIVER
RICHMOND
SURREY
LANGLEY
LEGEND
Municipal Boundary
Industrial Zone
Study Area
DELTA
BOUNDARY BAY
0 1 2 3 4 5 miles
Source: City of Vancouver Planning Dept
Roberts Bank

1974), Davis (1972), Steed (1973), Paulson (1976), Tennant (1977), and assorted government and consulting agencies too numerous to mention. These authors have reported a number of unique industrial characteristics associated with Metropolitan Vancouver.

The industrial structure of Vancouver differs from other North American cities in several respects. Steed (1973), in his assessment of manufacturing within the Vancouver metropolis, notes that production is extremely concentrated in several key activities at the first stage of resource processing. Wood and wood processing activities remain the central elements contributing to the economic growth of Vancouver. Whereas McGovern (1961) expressed the opinion that diversification into other activities was broadening the economic base of the metropolis and loosening the dependence upon resource-based activities, Steed disagrees.

> "Much of the expansion and diversification into secondary manufacturing in Greater Vancouver over recent years has, indeed, simply involved increasing integration with the provincial hinterland through the taking up of forward or backward linkages from this primary sector." (Steed 1973, 238)

Despite the importance of Vancouver as an international port, the manufacturing sector purchases a relatively large amount of inputs (by value) from the local area. Davis (1972) provides figures suggesting that 34 per cent of all manufacturing inputs were purchased from the local market. Although by itself this figure does not constitute the majority of total

inputs, it is appreciably larger than in other North American cities. Karaska (1969), in a comparable analysis of Philadelphia, noted that his sample of manufacturing firms received only 19.4 per cent of total inputs from local sources. Vancouver's relative isolation from the industrial heartland of North America and the high transport costs associated with importing non-local materials may provide a partial explanation for the substitution of imports with local materials. But the main reason is the high level of integration within the major resource industries noted above.

A conscious GVRD planning policy, formulated in the 1960s, has been to redistribute employment opportunities from the city to suburban regional town centres including New Westminster, Burnaby, Surrey and Coquitlam. This policy was directed at redressing the apparent imbalances (measured in 1971) between jobs and resident workers within each municipality. At that time the City of Vancouver had a surplus of jobs to resident workers (1.0 to 0.7) and most of the remaining suburban communities within the regional district had a surplus of resident workers to jobs (to a maximum ratio of 1.0 to 1.8 in Coquitlam, Surrey and Port Moody) (Vancouver, City Planning Dept. 1977, 4.5).

It seems however that this planning effort has been made redundant by the actual redistribution of industry (decentralization) since the objectives were formulated. The city's Economic Development Office found during a recent survey that, of 180 city

companies indicating that they were constrained in expansion by a lack of space or high central city land costs, 129 were considering relocation. Of these, 30 were considering another site in the city, 30 were considering a site in either the city or elsewhere, and the remainder (69 firms) were considering a site in the suburbs only (British Columbia Business Magazine 1980, 109). An alternate view is held by Steed (1973) and Tennant (1977). Their analyses concluded that the growth of industry at the periphery of the GVRD has occurred not as a result of an exodus of inner city industry but rather primarily from the birth of new industry in the suburbs.

Fraser River Port and the Port of Vancouver

An analysis of the influence of an alternate port upon industrial location requires, as a prerequisite, a descriptive comparison of general functional aspects of the two ports. Functionally, the Port of Vancouver (Burrard Inlet and Roberts Bank) and the Fraser Port differ in several aspects. The following discussion uses the shipping statistics contained in tables 4 and 5 to describe the general differences between these two ports. The first observation is the relative size of the ports as reflected by the total cargo tonnage shipped. According to Statistics Canada figures, Vancouver handled 39 million tonnes of cargo in 1978, compared to the Fraser River's 4.1 million tonnes. Vancouver has the largest volume of Canadian West Coast port traffic with the Fraser Port invariably ranked second. Together, the two GVRD ports constitute

TABLE 4

SHIPPING STATISTICS IN TONNES AND PERCENTAGES FOR THE FRASER RIVER PORT, 1978

	Imports			Exports			Total	Total	
Commodity[a]	Domestic	Inter-national	Total	Domestic	Inter.	Total	Imp. & Exp.	Domestic	Inter.
Dry Bulk	1805413 (86.1)[b]	83973 (16.3)	1889386 (72.3)	342126 (76.4)	645408 (59.6)	987534 (65.4)	2876920 (69.4)	2147539 (84.4)	729381 (45.6)
Wet Bulk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other Bulk (not yet specified)	58800 (2.8)	76021 (14.7)	134821 (5.2)	0 (0)	219508 (20.3)	219508 (14.3)	354329 (8.6)	58800 (2.3)	295529 (18.5)
General Cargo & Containers	233237 (11.1)	356590 (69.0)	589827 (22.5)	105622 (23.6)	218134 (20.1)	323756 (21.2)	913583 (22.)	338859 (13.3)	574724 (35.9)
Total	2097450 ((80.2))[c]	516584 ((19.8))	2614034 (100) ((63.1))	447748 ((29.2))	1083050 ((70.8))	1530798 (100) ((36.9))	4144832 (100) ((100))	2545198 (100) ((61.4))	1599634 (100) ((38.6))

Note: Consisting of all shipments made within the jurisdiction of the Fraser River Harbour Commission (therefore not including the North Arm of the Fraser); compiled from Statistics Canada, Transportation and Communication Division (1978, table 9)

[a] Commodities consist of Dry Bulk (limestone, wheat, logs, pulpwood, sand and gravel, cement), Other Bulk (bulk cargo not yet specified), General Cargo and Containers (lumber and timber, other general cargo)

[b] ( ) indicates percentages summing to 100.0 in a column

[c] (( )) indicates percentages summing to 100.0 in a row

TABLE 5

SHIPPING STATISTICS IN TONNES AND PERCENTAGES FOR THE PORT OF VANCOUVER, 1978

	Imports			Exports			Total	Total	
Commodity[a]	Domestic	International	Total	Domestic	Inter.	Total	Imp. & Exp.	Domestic	Inter.
Dry Bulk	2867313 (73.8)[b]	1333439 (44.3)	4200752 (60.9)	1826152 (50.8)	21309289 (74.8)	23135441 (72.1)	27336193 (70.1)	4693465 (62.7)	22642728 (71.9)
Wet Bulk	12039 (0.3)	0 (0)	12039 (0.2)	1280685 (35.6)	159669 (0.6)	1440354 (4.5)	1452393 (3.7)	1292724 (17.3)	159669 (0.5)
Other Bulk (not yet specified)	318753 (8.2)	992611 (33.0)	1311364 (19.0)	0 (0)	3142940 (11.0)	3142940 (9.8)	4454304 (11.4)	318753 (4.3)	4135551 (13.1)
General Cargo & Containers	687488 (17.7)	683758 (22.7)	1371246 (19.9)	488281 (13.6)	3877252 (13.6)	4365533 (13.6)	5736779 (14.7)	1175769 (15.7)	4561010 (14.5)
Total	3885593 ((56.4))[c]	3009808 ((43.6))	6895401 (100) ((17.7))	3595118 ((11.2))	28489150 ((88.8))	32084268 (100) ((82.3))	38979669 (100) ((100))	7480711 (100) ((19.2))	31498958 (100) ((80.8))

NOTE: including Roberts Bank; compiled from Statistics Canada, Transportation and Communication Division (1978, table 9)

[a] Commodities consist of Dry Bulk (barley, wheat, logs, pulpwood, coal, sand and gravel, salt, sulphur, potash, cement), Wet Bulk (hog fuel, gasoline, fuel oil), Other Bulk (bulk cargo not yet specified), General Cargo and Containers (containers, lumber and timber, pulp, newsprint paper, other general cargo).

[b] ( ) indicates percentages summing to 100.0 in a column.

[c] (( )) indicates percentages summing to 100.0 in a row.

77.6 per cent of all international cargo and 59.6 per cent of total cargo shipped through all British Columbia ports (1977 data).

The second characteristic differentiating the two ports is their relative export/import orientation. Port cargo at the Fraser River Port consists primarily of imports (63.1 per cent imports - 36.9 per cent exports). Cargo handled through the Port of Vancouver consists of 17.7 per cent imports and 82.3 per cent exports. The two ports differ in terms of the origin and destination of materials as well. Material linkages of Fraser River traffic are found predominantly along the Canadian west coast, as noted by the high degree of domestic imports and exports (61.4 per cent domestic - 38.6 per cent international). International linkages are of principal importance at the Port of Vancouver (19.2 per cent domestic - 80.8 per cent international).

Although cargo handled at the Port of Vancouver exceeds that at the Fraser Port, in both bulk and general forms, the two ports cannot be distinguished by their orientation towards bulk or general shipments. Bulk cargo accounts for 78 per cent of total cargo handled along the Fraser River - Main Arm. Vancouver port statistics indicate that bulk cargo accounts for a substantial portion (95.2 per cent) of their total cargo as well. The difference between these two percentages is small. There is a difference, however, in the amount of cargo handled at the two ports classified as wet bulk. At the Port of Vancouver 3.7

per cent of total cargo shipped was classified as such (primarily fuel oil and gasoline). The overwhelming majority of this was destined for the offshore British Columbia islands (particularly Vancouver Island). By comparison, there were no wet bulk shipments from the Fraser River Port, although a small amount could be contained within the other bulk category.

There are several more specific differences contained within the shipping statistics indicating that the Fraser River Port could be classified a manufacturing port while the Port of Vancouver may be considered a transshipment port. One indicator of the amount of manufacturing activity at the port (i.e., the use of waterborne cargo in production by a firm located at the waterfront) is the importance of bulk imports to total shipments. Because the land transport costs per unit for shipping bulk raw materials is relatively high, manufacturers requiring these inputs in large amounts tend to seek out waterfront locations.

The statistics indicate that bulk cargo imports play a much more important role at the Fraser Port than they do at the Port of Vancouver. Bulk imports constitute 48.8 per cent of total cargo handled along the Fraser River. By comparison, only 14.2 per cent of total shipments through the Port of Vancouver are classified as bulk imports. Although general cargo is often processed further as well, the unitized nature of the packaging and higher value of the product per unit weight do not restrict general cargo users to waterfront locations only. The cost savings inherent in

containerization and other unitized general cargo handling techniques are maximized through the intramodal movement of general cargo, thereby warranting the movement of unitized cargo and the location of users away from the relatively more expensive waterfront sites.

Conversely, a measure of the port's importance as a transshipment point is provided by the emphasis placed upon bulk exports. In general, greater emphasis upon bulk exports is accompanied by a reduction in waterfront manufacturing activity. This inverse relationship holds true because waterfront space allocated to bulk terminals reduces the land available for port manufacturing. At the Port of Vancouver, 71.1 per cent of cargo handled (by weight) consists of bulk exports. When the influence of coal exports from the outerport Roberts Bank terminal are eliminated, bulk exports still account for approximately 64 per cent of total traffic. The export of bulk materials through the Fraser Port accounts for only 29.1 per cent of total cargo shipped.

Delimitation of Study Area

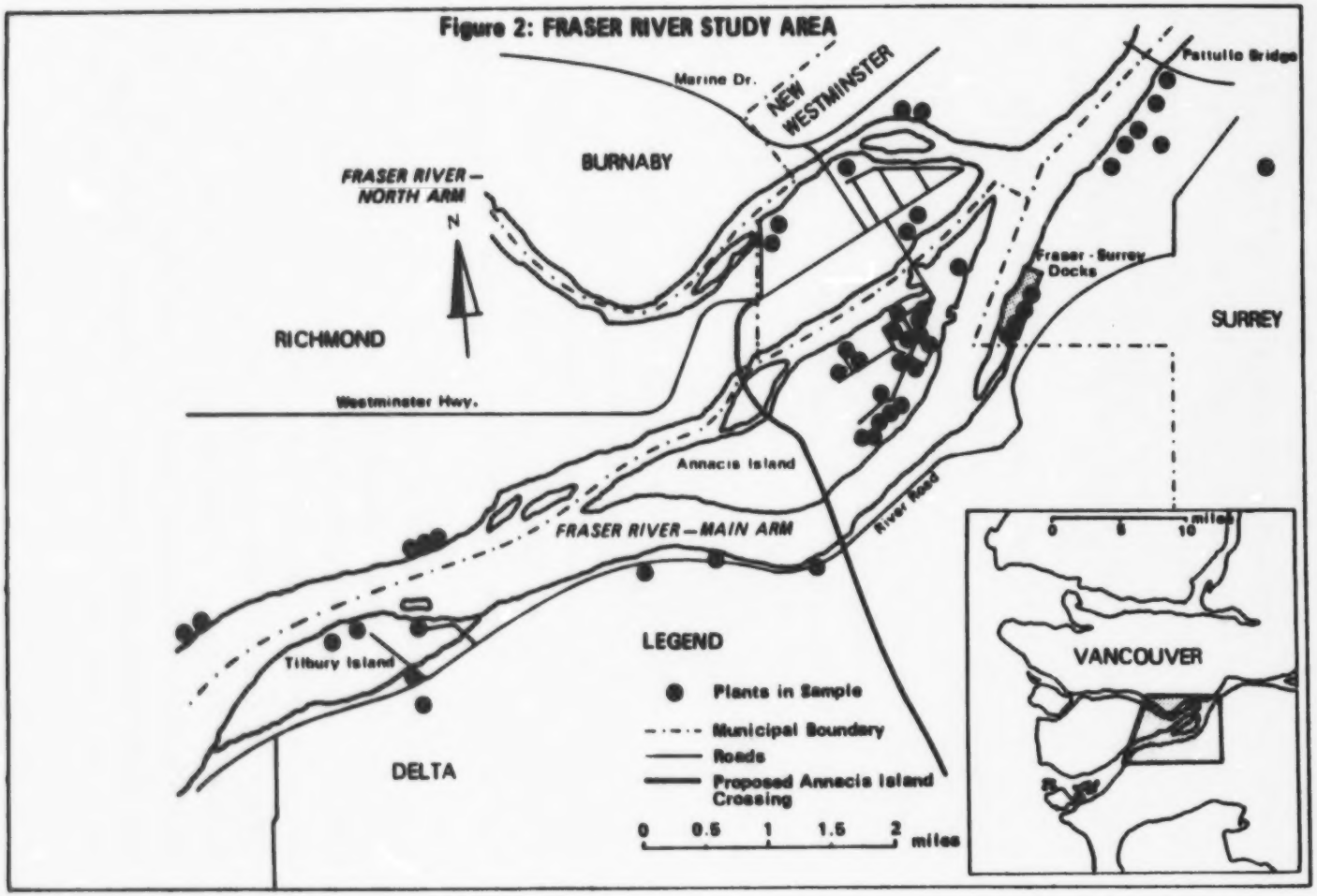
In identifying the limits to the study area it must be emphasized that the diverse forms of data gathered have created two levels of study. At the macro level, location factors are examined throughout the entire Metropolitan Vancouver. Information gathered at this level is more general in nature and is used to determine spatial variations for a variable at an aggregate level. This analysis forms the basis of

chapter 5. Because of research constraints in terms of available time and money, all of the factors hypothesized as being important in the intrametropolitan location of manufacturing could not be analyzed at this scale. Therefore, in order to examine the linkage patterns, character profile, and potential development of suburban industry, a more intense analysis of a major suburban industrial area was conducted.

This industrial area is located adjacent to the main arm of the Fraser River approximately 11 miles south and east of the central business district of the City of Vancouver (see figure 2). Following the Fraser River, the study area extends from New Westminster in the east (the Pattullo Bridge being a convenient demarcation point) to the Deas Tunnel in the west, a distance of ten miles. Represented within this area are the municipalities of New Westminster, Surrey, Richmond, and Delta. Although almost the entire foreshore is zoned industrial, the major concentrations of industry occur at Annacis Island, the Fraser-Surrey deepwater docks and Surrey waterfront, and Tilbury Island (including adjacent land on the south shore).

This area was chosen because it is growing industrially and holds potential for future growth. In addition, the presence of a navigable waterway permits the examination of the influence of a port upon industrial location. The eastern boundary was drawn at the Pattullo Bridge to conform to this latter site selection factor. Draught restrictions east of the bridge and the potential shipping hazard associated with

Figure 2: FRASER RIVER STUDY AREA



the accompanying railway bridge have prevented deep-water vessels from travelling upstream of New Westminster (Robinson 1971, 1965). To the west, the Deas Tunnel was considered a suitable delimiting point because industrial land uses are not prominent beyond this point (a notable exception is the Riverside Industrial Park). Although a significant portion of waterfront land adjacent to the North Arm of the Fraser River is used for industrial purposes, it was omitted because draught restrictions (3 metres at high tide) prohibit deepsea shipping and the potential for further industrial growth in the area is limited.

Survey Methodology

Field research, conducted primarily within the Fraser River industrial area, was completed during two five-week periods in the summers of 1979 and 1980. The survey of firms within the area was administered by a series of personal interviews using a predeveloped questionnaire (see appendix I). This questionnaire was revised to suit the existing individual site characteristics and objectives from a study conducted by Ainlay (1978) on industry at the Port of Toronto. Incorporating both open-ended and closed questions, the questionnaire was designed to gather information concerning the following features of the individual firm: personal characteristics, linkage relationships and distributional patterns, transport requirements (with particular emphasis upon water transport), and locational considerations.

It was determined that a personal interview format

would be more successful in gathering the necessary information than mailed questionnaires, despite additional costs incurred and time used. Those factors warranting a personal interview type of questionnaire are identified by Warwick and Lininger (1975, 129-130),

> "...the personal interview is usually more appropriate than self-administered questionnaires when the survey covers highly diverse individuals with little intrinsic interest in the subject matter, when the questionnaire is likely to be long or the items complex, and when the study calls for more than one or two open-end questions."

All three of these criteria are applicable to the questionnaire used in this analysis.

The following advantages were gained by conducting personal interviews. First, and foremost, the response rate was much higher than one would have expected with mailed questionnaires. Of the 55 firms initially contacted, 50 were interviewed. Although primarily attributable to the survey method employed, this high response rate can also be explained by the fact that the study was partially funded by and therefore associated with a federal government agency (the Canadian Transport Commission). This association made respondents more amenable to divulging confidential information.

Secondly, by establishing rapport with the respondent, answers were more complete and accurate than would have been the case with mailed questionnaires. Because the interviewer was present to interpret or

elaborate any questions, potential problems were minimized. In addition, the interviewer was able to probe responses pertaining to relevant issues or problems raised by the respondent that may not have been elaborated upon had mailed questionnaires been used.

Two basic sources were used to provide a set of respondents. The British Columbia Manufacturers' Directory for 1978 and 1979 (Province of British Columbia, Ministry of Economic Development 1978 and 1979) provided a listing of resident firms together with their addresses, range of products manufactured, approximate number of employees, phone number, and in some cases the name of a company representative. Although instances arose where information was outdated, discrepancies were discovered and eliminated by crosschecking with the Vancouver general telephone directory.

Interviews were prearranged by telephone. These interviews, lasting between thirty and sixty minutes, were conducted with company representatives considered to have a working knowledge of the many diverse aspects of a firm. Typically, representatives held the position of owner, plant manager, or public relations spokesman. Where the initial contact could not provide the necessary information, the questionnaire was circulated to the most applicable employee (e.g., traffic manager for input/output information).

Because of time constraints noted earlier, and with the objectives of the study in mind, the entire

population of industries within the Fraser River Port study area was not interviewed. Instead, a sample of 50 industries employing a total of 6,715 persons was selected (an average of 134.3 employees per plant). The sample, considered representative of manufacturing throughout the entire study area, was formed with respect to the following two criteria. Because an essential component of the study was a determination of the influence of the Fraser River upon industrial location, firms located at the waterfront were included in the sample. In addition, those firms having the greatest impact upon the area (i.e., the largest in terms of employment, land occupied, etc.) were given precedence in selection.

The combination of these qualifications and the use of the manufacturing directory in the sample selection process, allowed manufacturing to be the most common activity represented. Forty-two (84 per cent) of the firms interviewed engaged in some form of manufacturing as their principal function. The remaining firms specialized in warehousing or distributional activities. The manufacturing firms selected produced a broad spectrum of products, thereby eliminating potential bias that may have occurred had the range of manufacturers been too narrow. Representation within manufacturing encompassed wood products industries, pulp and paper industries, metal fabricators, non-metallic minerals industries, rubber industries, fish processors, etc.

More general data, gathered at the metropolitan

scale, were obtained from various sources. Metropolitan wage rate information was acquired from the Vancouver offices of the federal Department of Employment and Immigration. Compiled from all regional branch offices of Canada Manpower, it consists of wages for jobs posted at each branch for employment within their respective operating regions. The wage listings recorded cover a four-month period ending June 27, 1980.

Industrial land costs for various sizes of land parcels within the industrial districts of the GVRD were acquired from the industrial sales branch of a prominent real estate company. These land costs were current to the summer of 1980. Secondary research sources included Statistics Canada reports on shipping, industrial wages, and capital investment, and discussions with municipal planners and consultants.

Limitations

The major limitation associated with any type of survey data is the proportionately higher level of error accompanying it. False or inaccurate information supplied by the respondent is a problem that is common to many surveys, especially where attitudinal and 'confidential' information is requested. The effect of error has been minimized in this survey by having the questionnaires circulated to more than one company representative. Where necessary, follow-up interviews were arranged to provide the company representative time to answer more accurately the entire questionnaire.

In addition, by crosschecking responses, especially those involving personal characteristics of the firm (e.g., physical site dimensions, waterborne transportation patterns), with secondary sources (e.g., air photo maps, harbour commission statistics), the confirmation or reevaluation of data were made possible.

Although collecting data over two separate periods (summers of 1979 and 1980) may have had an effect upon the accuracy of the results, it is clear that there was only very minor change in industrial structure and linkage patterns between the two groups during the intervening ten-month period. In any event, the larger sample size achieved by the subsequent research compensated for any small inaccuracies that may have been introduced into the results.

The size of the sample (50 plants) was not deemed to be a hinderance to conclusions because a large proportion of manufacturing activities within the study area was interviewed. Although it has been noted that manufacturing activities received primary importance in the selection process this has not biased the results because (1) manufacturing was the dominant economic activity within the study area, and (2) the emphasis upon manufacturing was in accordance with the objectives. A final limitation to be addressed deals with the applicability of the analysis and results. Information gathered and conclusions drawn from the analysis of the Fraser River industrial sample apply only to the population of industry within that study area. However, inferences can be made that allow for the comparison of these results to other similar areas.

CHAPTER 4

DESCRIPTION AND ANALYSIS OF FRASER RIVER INDUSTRY

Water Transport Structure

As a major Canadian port city, Vancouver has developed a large and complex water transportation system. Three separate port authorities operate in four distinct port areas. The National Harbours Board operates the Port of Vancouver (Burrard Inlet) and the Roberts Bank outerport terminals, the North Fraser River Harbour Commissioners control port development along the North Arm of the Fraser River and the Fraser River Harbour Commission (FRHC) have comparable authority over the Main Arm of the Fraser River (see figure 3).

In addition, maximum draught varies at the four metropolitan ports. Burrard Inlet has an operating draught of 50-55 feet, while at the Roberts Bank outerport terminal maximum draught exceeds 60 feet. The Main Arm of the Fraser River provides a draught of only 33 feet on a 13-foot tide and, on the North Arm of the Fraser River draught restrictions (maximum of 15 feet) prohibit all deep-sea vessels from entering. Because of draught restrictions applicable on the Fraser River (in comparison to Burrard Inlet), the Fraser River Port can accommodate only those vessels of less than 45,000 deadweight tonnes (dwt.).

The main deep-sea docking berths within the Fraser River study area are the Fraser-Surrey public docks, Pacific Coast Terminals Co. Ltd., Fraser Annacis Autoport,

Fraser Wharves Ltd., and Dow Chemical of Canada Ltd. The Fraser-Surrey docks, built in 1975, occupy 169 acres of waterfront land along the south shore of the Fraser River directly across from the eastern tip of Annacis Island (see figure 2). Six berths, including five deep-sea berths, two unit cranes, and 120 acres of backup land facilitate the movement of general cargo and containers. "Major products handled include steel, forest products, and containerized and roll-on/roll-off general cargoes." (Fraser River Harbour Commission 1976).

Pacific Coast Terminals Ltd., the oldest existing deep-sea berthing facility along the Fraser River, is located on the north shore of the Fraser River, within the City of New Westminster, downstream from the Pattullo Bridge. In 1979, this facility consisted of 11 berths with only 35 acres of backup land. Although traditionally an important docking facility, these terminals are now being phased out. Urban redevelopment pressure from New Westminster, and a lack of backup land that hinders efficient movement of unitized cargo, are two of the major factors responsible for discontinuing the operation of these facilities. The Annacis Island Autoport, built and operated by the Fraser River Harbour Commission, is located on reclaimed land at the eastern tip of Annacis Island. Deep-sea auto-carrying vessels, to a maximum of 20,000 dwt., use the 560-foot long berth on a roll-on/roll-off or self-unloading basis.

The remaining two deep-sea berthing facilities within the study area are privately owned and operated

(Dow Chemical Co. Ltd. and Fraser Wharves Ltd.). They are used, respectively, for the unloading of toluene and automobiles from Japan. In addition to these deep-sea terminals, a large number of private companies have docking facilities for the movement of shallow draught ships (coastal traffic). The majority of the cargo handled through these docks consist of bulk products, specifically logs, residue lumber products, sand, and gravel. These private users form part of the sample group of industrial firms interviewed.

Trade, as measured by the total amount of cargo shipped, has increased dramatically throughout the 1970s. Table 6 shows, in aggregate, the change in shipping characteristics over a seven-year period from 1972 to 1979. Some of the more noteworthy facts contained within this table are summarized as follows:

1. Total traffic handled has increased by 49 per cent from 1972 to 1979. Large increases in both deepsea and coastal traffic combined to produce this result.
2. The number of deepsea vessels docking annually decreased by 20.4 per cent over this same time period. Combined with the increase in amount of deepsea cargo handled, this infers an 83.5 per cent increase in the average load per ship.
3. The ratio between deepsea exports and imports remain virtually unchanged over the seven-year period at approximately 2 to 1.

Changes also occurred in the origin/destination patterns of deep-sea cargo shipments. Table 7 reveals

TABLE 6

AGGREGATE TRENDS IN FRASER RIVER PORT CARGO MOVEMENTS, 1972 and 1979

	1972	1979	Change
Total Deep-Sea[a]	1,515,097	2,212,240	+697,143 (46.01%)
Total Coastal	1,789,655	2,711,208[b]	+921,553 (51,49%)
Total	3,304,752	4,923,448[c]	+1,618,696 (48.98%)
No. of Deep-Sea Vessels	490	390	-100 (20.41%)
Average Load/Deep-Sea Vessel	3,092.03	5,672.4	+2,580.4 (83.45%)
Deep-Sea Imports	486,729	732,767	+252,038 (51.78%)
Deep-Sea Exports	1,028,175	1,473,473	+455,298 (43.31%)
Deep-Sea Export/ Import Ratio	2.112 : 1	1.99 : 1	

SOURCE: compiled from Fraser River Harbour Commission Annual Reports (1972 and 1979)

[a]cargo is measured in tonnes. Slight rounding errors in the 1972 data are attributable to conversion from Imperial to the Metric measurement systems

[b]1979 figure was unavailable, so 1978 figure was substituted

[c]consists of 1979 deep-sea cargo and 1978 coastal cargo

TABLE 7
DESTINATION OF FRASER RIVER PORT EXPORTS, 1972 and 1979

Destination	1972 (%)	1979 (%)
Pacific rim Countries (except U.S.A. and South America)	66.4	76.3
U.S.A. and South America	12.2	15.9
Europe and United Kingdom	14.8	7.5
Elsewhere	6.6	0.3
Total	100.0	100.0

SOURCE: compiled from Fraser River Harbour Commission Annual Reports (1972 and 1979)

NOTE: as measured by weight

that the Pacific rim countries (Asia, Oceania, Australia, Japan, etc.) and the United States and South America have become more important international markets for exports from the Fraser River Port. Conversely, European and other markets (mainly in Africa) have declined in importance as cargo destinations.

The opposite trend is discovered when the cargo import origins are examined (see table 8). Here, Pacific rim countries, the United States, and South America, declined in relative importance as points of cargo origin (from 87.2 per cent to 69.2 per cent of total cargo by weight). Counteracting this decrease, Europe and 'Elsewhere' increased their share of total imports received at the Fraser Port (from 12.8 to 30.8 per cent of total cargo).

Rail Transport Structure

With the importance accorded Metropolitan Vancouver as a gateway for the movement of products to and from the Canadian interior, the existence of an extensive metropolitan rail network is not surprising.

Figure 3 shows the distribution of main rail lines within the GVRD. The most notable characteristic of this map is the presence of five railway companies controlling different lines within the metropolitan boundaries: Canadian National (CNR), Canadian Pacific (CPR), British Columbia Rail (BCR), British Columbia Hydro Rail (BCHR), and Burlington Northern (BNR). British Columbia Rail and British Columbia Hydro Rail

TABLE 8

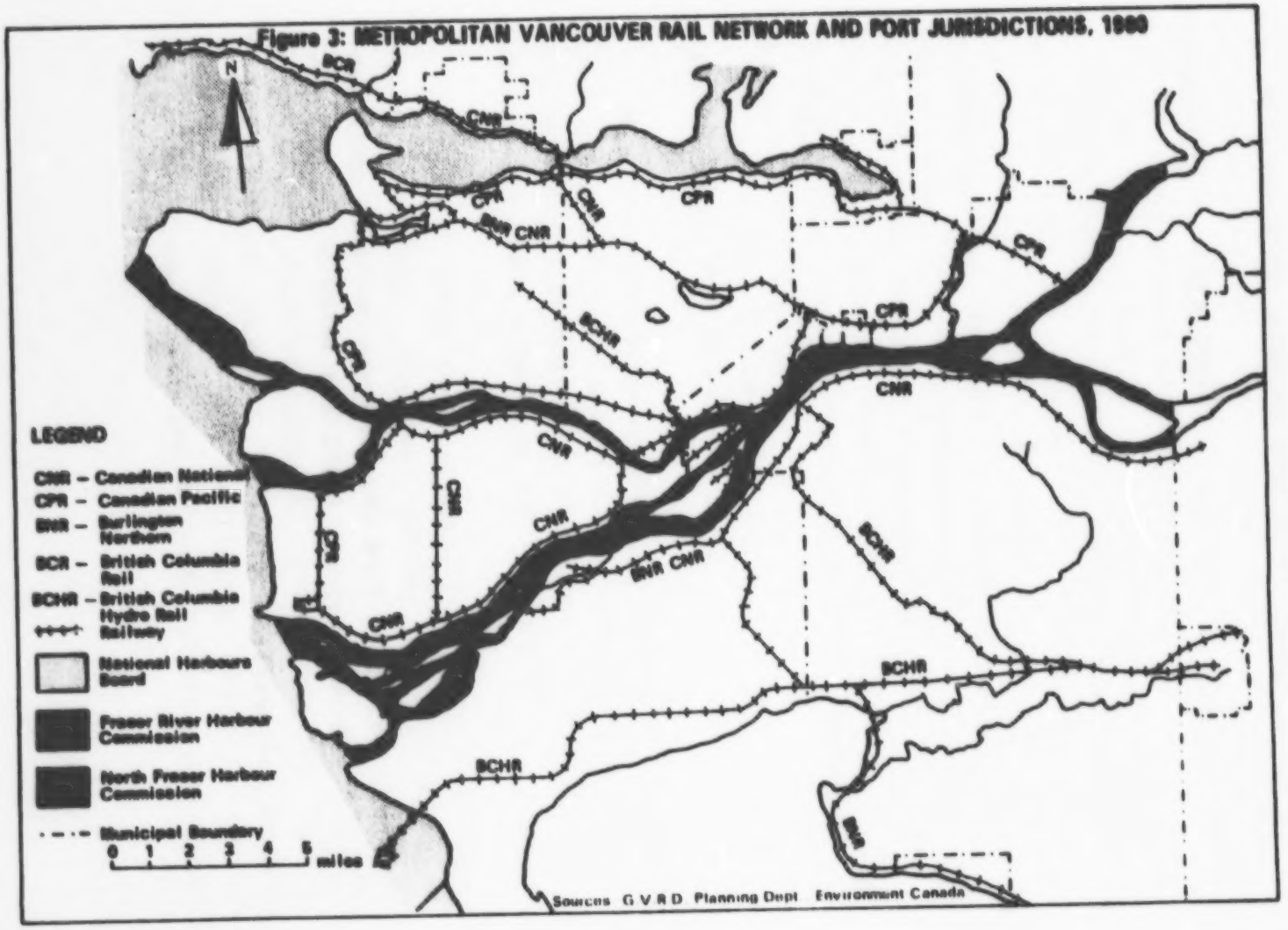
ORIGIN OF FRASER RIVER PORT INPORTS, 1972 and 1979

Destination	1972 (%)	1979 (%)
Pacific rim Countries (except U.S.A. and South America)	74.2	56.5
U.S.A. and South America	13.0	12.7
Europe and United Kingdom	11.4	21.0
Elsewhere	1.4	9.8
Total	100.0	100.0

SOURCE: compiled from Fraser River Harbour Commission Annual Reports (1972 and 1979)

NOTE: as measured by weight

Figure 3: METROPOLITAN VANCOUVER RAIL NETWORK AND PORT JURISDICTIONS, 1980



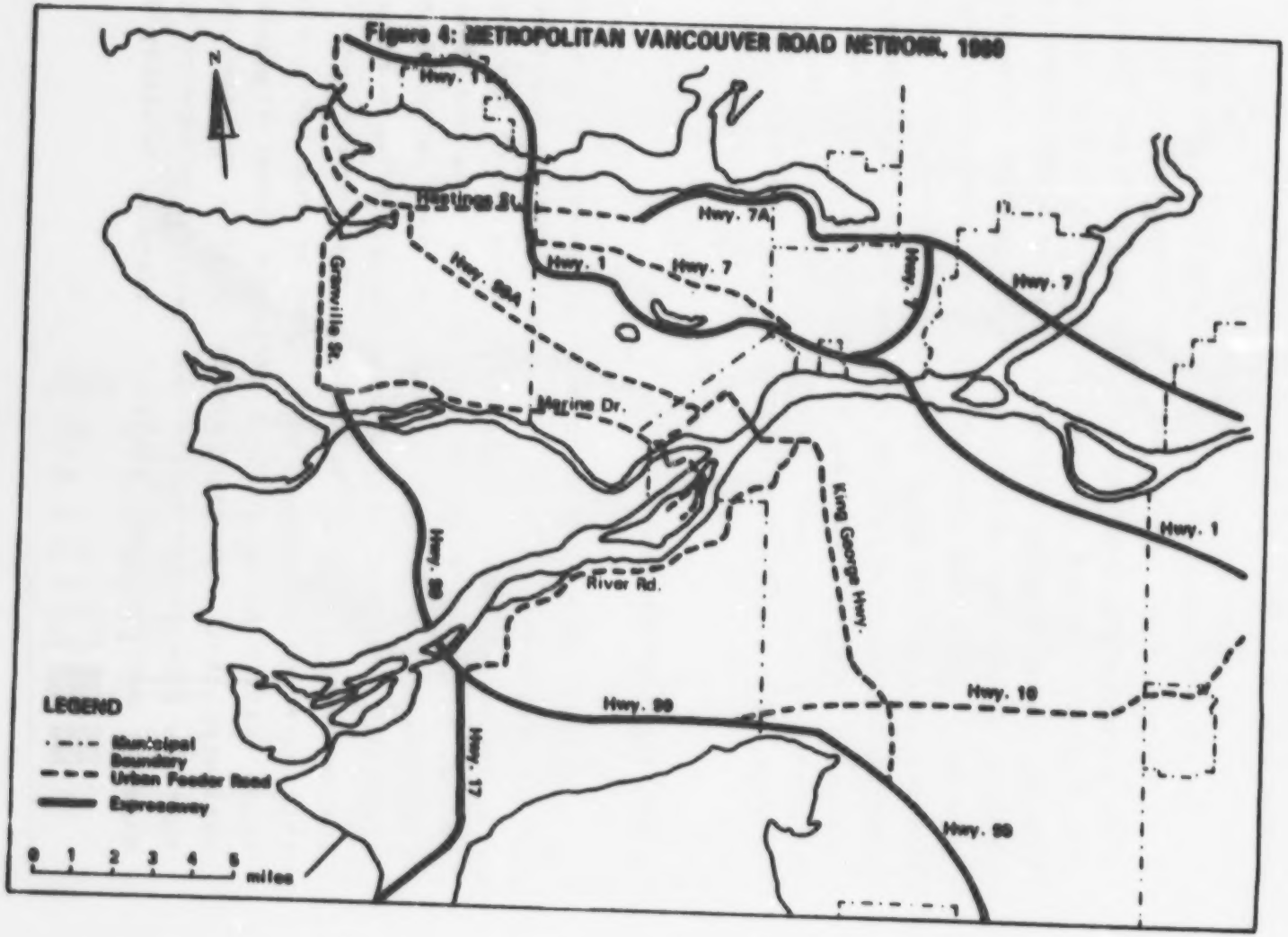
operate solely within British Columbia. Burlington Northern Rail operates within British Columbia and the United States.

Different suburban industrial complexes are served by different rail companies. The Fraser River study area is served by Canadian National on the north shore. The Annacis Island industrial complex relies upon British Columbia Hydro trackage, and the south shore is jointly served by Burlington Northern and Canadian National. Only the Port of Vancouver industrial area has access to both major rail lines, CN and CP. This semi-monopolistic situation has one major shortcoming. Switching problems, created in the present system by the movement of rail cars from one-company's lines to another, are a source of complaint for resident industry.

Road Transport Structure

Several characteristics must be noted with respect to the expressway system within Metropolitan Vancouver (figure 4). First, unlike most major North American cities, Vancouver's expressway network does not penetrate the central city. As such, the Port of Vancouver industrial area must rely upon the city road network for the movement of cargo by truck. The inefficiency of this existing network is reflected by the speed with which traffic moves in this area. A recent study has estimated that, "average speeds of 13 - 15 miles per hour are experienced during peak periods on some of the streets used by port traffic" (Canada, Ministry of

Figure 4: METROPOLITAN VANCOUVER ROAD NETWORK, 1980



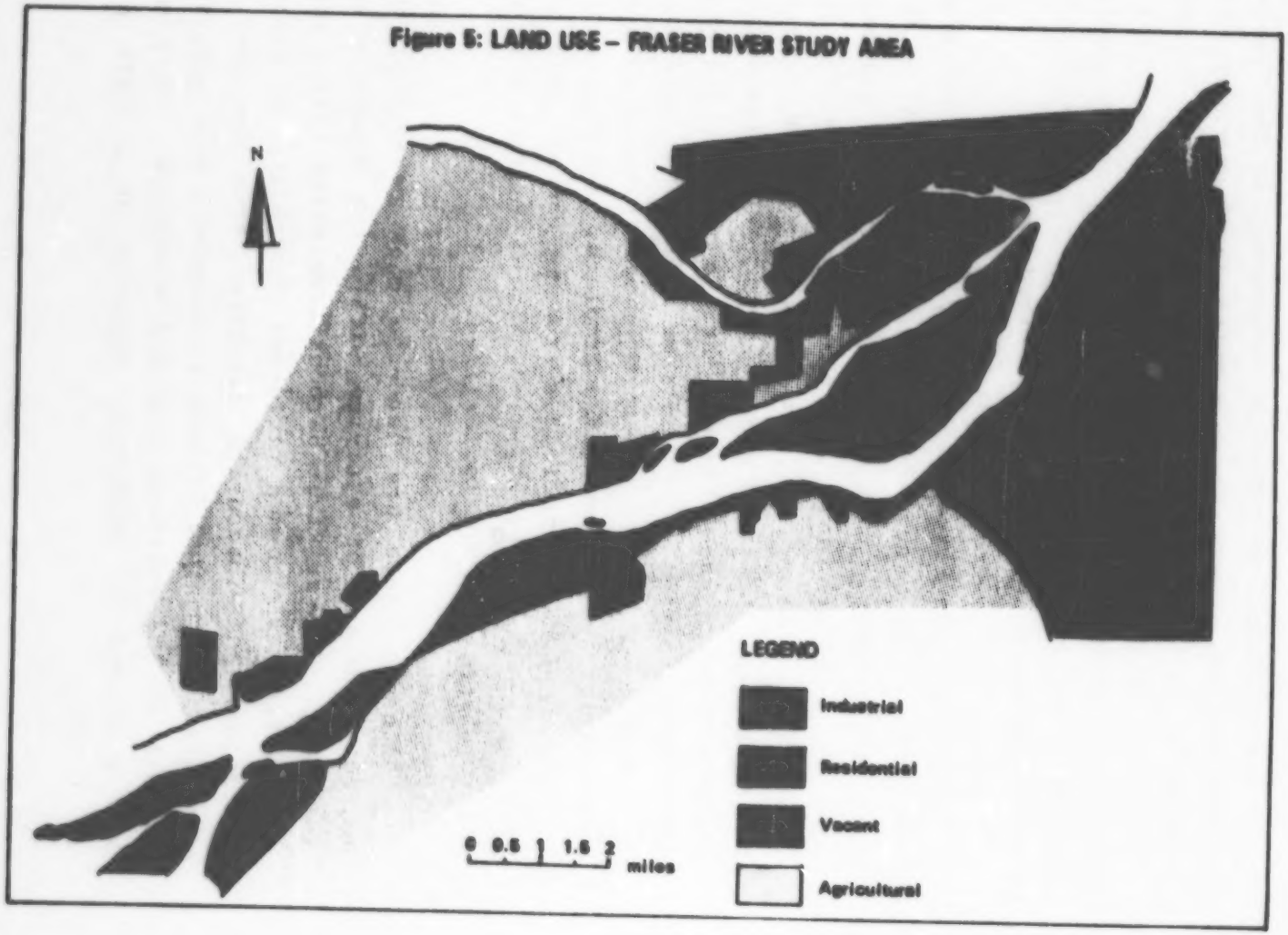
State for Urban Affairs 1978a, 79).

The principal metropolitan expressway is the Trans-Canada Highway (Hwy. 1). Running from northwest to southeast within the GVRD, it comes no closer to the central city than the Burnaby/Vancouver municipal boundary. The expressway portion of the second major metropolitan road, Highway 99, begins in Richmond and continues south and east to the United States.

Although the Fraser River study area is in suburban Vancouver it also suffers from access problems to the major expressways. Lack of immediate access to expressways is a major issue for the companies on Annacis Island (only one bridge serving more than one hundred companies) and the south shore (River Road is inadequate for the needs of manufacturers located there). The proposed new crossing of the Fraser River from Vancouver over Annacis Island to the south shore (n.b., figure 2) should alleviate some of these problems. However, without an adequate feeder road system to connect this new crossing to the major expressways, the full benefit of this crossing will not be realized.

Although there are land-use maps describing the aggregate nature of activity within the Fraser River area (e.g., Fraser River Harbour Commission 1972), they suffer from two common problems: generality in representation, and inaccuracy resulting from the use of outdated information. Figure 5 presents a more accurate picture of the existing land use structure. This map was produced by combining aspects of a 1976 air

Figure 5: LAND USE – FRASER RIVER STUDY AREA



photograph, existing land-use maps, and personal observation (1979 and 1980).

The most visible feature of this map is the large area of vacant and agricultural land, seemingly incongruous within a metropolis. Although all of the waterfront land within the study area has been zoned for industrial uses, a large portion of this land is in agricultural use or is vacant. Much of this land remains agricultural because it is being held in an agricultural land reserve.

Three areas are being actively developed for industrial purposes at the present time. Two of these, the central part of Annacis Island and the inland areas of Tilbury Island, are partially filled with tenants and/or owners. The third, upstream from and adjacent to the Fraser-Surrey docks, has not yet reached this stage of development.

A fourth industrial community, still in the planning stages, is situated in Richmond on the north side of the Fraser River (downstream from Annacis Island). This 665-acre waterfront site, often referred to as the Fraser-Richmond site, is being planned and developed by the Fraser River Harbour Commission to be the focus of future port-related industrial development.

The firms interviewed within the Fraser River study area were selected with respect to the methodology described in the previous chapter. Personal interviews were conducted using a questionnaire as the base (appendix I). From this questionnaire, it was possible

to differentiate firms over a range of features. Appendix II lists 110 variable names and descriptions that correspond to these features.

Description and Analysis: Fraser River Firms

Manufacturing was stated as the principal economic function for the majority of the firms within the sample, accounting for forty-two of the fifty firms or 84 per cent. The remaining 16 per cent specified warehousing or distribution activities as their principal function. Table 9 shows the specific activity of sample firms (at the two-digit S.I.C. level). The manufacturing firms have been further aggregated into light and heavy manufacturing groups as defined by Czamanski and Czamanski (1976).

There is strong representation from both light manufacturing (nineteen firms) and heavy manufacturing (twenty-three firms). However, within each of these groups one manufacturing sector dominates. Wood and wood products manufacturers account for 14 of the 19 light manufacturers (73.7 per cent). Similarly, metal fabricating predominates within the heavy manufacturing group, with 13 of the group's 23 firms falling into this sector (56.5 per cent).

Thirty of the fifty firms interviewed were located on the waterfront of the Fraser River (table 10). Twenty-two (73.3 per cent) of these waterfront firms used the river for the transportation of raw materials or finished products. The definition of 'use' is

TABLE 9

FUNCTIONAL PROFILE OF FRASER RIVER INDUSTRY, 1980

Activity[a]	No. of Firms	%	No. of Firms	%
Light Manufacturing[b]:				
Food and Beverage	2	4.0		
Wood and Wood Products	14	28.0	- 19	38.0
Pulp and Paper Products	3	6.0		
Heavy Manufacturing[b]:				
Primary Metal Ind.	1	2.0		
Metal Fabricators	13	26.0		
Non-Metallic Minerals	6	12.0	- 23	46.0
Rubber Products	1	2.0		
Chemical Ind.	2	4.0		
Warehousing and/or Distribution	8	16.0	- 8	16.0
TOTAL	50	100.0	50	100.0

SOURCE: from Fraser River industrial survey, 1979 and 1980

[a]Activities are classified according to the Standard Industrial Classification (S.I.C.) system, at the two digit level, used for Canada Census publications; where a firm engages in more than one activity it is classified according to its principal activity.

[b]Basis for this form of aggregation derived from Czamanski and Czamanski (1976).

TABLE 10
WATER TRANSPORT ORIENTATION - PRIVATE DOCKING FACILITIES

	No. of Firms	%		No. of Firms	%
Not Waterfront Firms	20	(40.0)			
Waterfront Firms	30	(60.0)	- Port Facilities	22	(73.3)
			- No Port Facilities	8	(26.7)

SOURCE: from Fraser River industrial survey, 1979 and 1980

flexible, ranging in nature from tug-drawn log booms and wood chip scows to the shipment of cargo internationally via deep-sea vessels. This characteristic, providing an estimate of the marine transport linkages of various firms and activities, will be expanded upon shortly.

A complementary characteristic in describing the port/non-port orientation of a firm is its tendency to make use of public docking facilities. Firms not at the waterfront could still have strong indirect port linkages if they require the services of public docking facilities for the transshipment of raw materials or finished products. Table 11, in disaggregating the entire group of firms (at both waterfront and inland sites), found a large proportion of firms using public docking facilities (68 per cent). Specifically, 25 of the 34 firms using central docking facilities used the Fraser-Surrey docks to some extent. Fourteen of these 25 used the Fraser-Surrey docks exclusively. Although these figures understate the strength of marine linkages (as will be noted in a commodity flow analysis following), they do indicate that movement of commodities by ship is a common element of the transport structure of Fraser River industry.

In order to provide a profile of industry within the Fraser River study area, some major features have been analyzed. Several variables provide a good measure of the locational history, relative size, corporate structure, and relocational potential of the Fraser River firms. In comparison to the inner city industrial district, the Fraser River industrial area is relatively

TABLE 11
WATER TRANSPORT ORIENTATION - PUBLIC DOCKING FACILITIES

	No. of Firms	%
Use Public Docks[a]	34	(68.0)
No Use of Public Docks	16	(32.0)

SOURCE: from Fraser River Industrial Survey, 1979 and 1980

[a]The most commonly used public docks are Fraser - Surrey (Fraser Port), Vanterm, Lynterm, and Centennial Pier (Port of Vancouver)

young. The median date of establishment for the sample of firms surveyed was mid-1964. Seventy-one per cent of all establishments were located here after 1960. Development has occurred as a result of two forces. Of the firms interviewed, 31 (62 per cent) are original owners or tenants at their site while 19 (38 per cent) have taken over an existing building and facilities. The high proportion of first owners/tenants still at the site is an indication of the youth and stability of the industrial area.

Indicators of firm size include the actual size in acres, the number of employees, book value of the plant, and total inputs and outputs (by weight). Taking each of these in turn, the following is found. As might be expected in a suburban industrial community, property sizes are large, averaging 20.2 acres. This average size far exceeds that found within the industrial districts of the City of Vancouver. In 1977, a City Planning Department study revealed that the average size for all manufacturing establishments within the city was less than two acres (Tennant 1977, 32). This same study indicated that in 1976 the city had a total of 1,242 acres of industrial land, just slightly greater than the total land occupied by the 50 sample firms within the Fraser River study area (1008.65 acres).

Within the Fraser River industrial sample there was a mean of 134.3 employees per firm, while the median number of employees per firm was 96. This latter figure is perhaps a more applicable measure of central tendency. In comparison, an industrial sample of 38

firms in Toronto's central city port area had a mean of 143 employees/plant (Ainlay 1978). The median number of employees, justifiably noted because of a highly skewed distribution, was only 43. These figures indicate that the median number of employees at the suburban firm far exceeded the equivalent central city firm. This difference is consistent with the incubator hypothesis in that as firms grow in size they internalize their economies of scale and seek out suburban sites.

Book value of the plant and facilities would normally be a good indicator of the relative size (in terms of investment) of Fraser River industry. However, despite a high response rate to this question (40 of 50 respondents supplied an answer), the validity of the mean book value of $8.618 million must be questioned. For reasons of confidentiality, this response is most prone to error. A much more accurate measure of firm size, relatively unhindered by this problem of confidentiality, is the total annual amount of inputs and outputs, by weight, of sample firms.

The average amount of raw materials used annually by the Fraser River firms was 127,124.1 tonnes. The median amount of material inputs was 44,296 tonnes. The mean and median amount of outputs annually were, respectively, 82,631.4 and 30,000 tonnes. For comparative purposes, Ainlay's sample of central city port firms within Toronto utilized an average 99,440.9 tonnes of raw materials. This figure is considerably lower when oil shipments (approximately 43 per cent of the total) are subtracted.

Another important characteristic of Fraser River industry is its corporate ownership structure. In Canada, corporate ownership or control of manufacturing is commonly based in the United States or abroad (Britton and Gilmour 1978). Industry at the Fraser River does not seem to reflect this feature. Eighty-four per cent of the firms interviewed had head offices within Canada. Of the fifty firms, 56 per cent had head offices located within Metropolitan Vancouver.

Commodity Linkages: Fraser River Industry

Commodity linkages of Fraser River firms were determined by analyzing the origin/destination patterns and modal split of industrial cargo by weight (tonnes). A dollar figure, representing value, would have been more representative of the actual pattern of inter-industry linkages, enabling the production of a modified input-output table. However, the reluctance of many firms to divulge this 'confidential' information combined with the proportionately higher degree of variability associated with this form of measurement, precluded its usefulness. Instead, tonnage figures have been substituted and have proven an adequate measure of the pattern of industrial linkages.

Tables 12 and 14 show respectively, in aggregate form, the origin/destination flows of Fraser River industrial commodities and the mode of transportation for the movement of these commodities. In order that the results are not unduly affected by deviant values (i.e., much larger or smaller amounts of commodities

TABLE 12
AGGREGATE FRASER RIVER COMMODITY FLOWS: ORIGINS/DESTINATIONS (BY % OF TONNES)

	Inputs (%)	Outputs (%)	Total (%)
GVRD	26.5	38.1[a]	31.8
Rest of B.C.	37.3	19.3[a]	32.1
Rest of Canada	9.2	17.9	11.6
U.S.A.	6.1	14.9	9.7
Overseas	20.9	9.7	14.9
Total	100.0	99.9	100.1

SOURCE: from Fraser River Industrial Survey, 1979 and 1980.

[a]Firms frequently did not delimit market areas by a GVRD/B.C. boundary. For that reason the average percentage output assigned to GVRD and the rest of B.C. may not be as distinct as it appears.

TABLE 13

ORIGIN - DESTINATION COMMODITY LINKAGES OF FRASER RIVER INDUSTRY BY MANUFACTURING TYPE

HEAVY MANUFACTURERS[a]

	Inputs (%)	Outputs (%)
GVRD	30.2	50.1
Rest of B.C.	15.9	22.1
Rest of Canada	13.3	14.3
U.S.A.	11.8	12.9
Overseas	28.8	0.6
Total	100.0	100.0

LIGHT MANUFACTURERS[b]

	Inputs (%)	Outputs (%)
GVRD	18.2	24.8
Rest of B.C.	77.8	12.2
Rest of Canada	1.4	19.3
U.S.A.	1.3	23.7
Overseas	1.3	20.0
Total	100.0	100.0

SOURCE: from Fraser River industrial survey, 1979 and 1980

[a]Heavy manufacturers composed of primary metal, metal fabricating, non-metallic minerals, rubber products and chemicals sectors.

[b]Light manufacturers composed of wood products, pulp and paper products and food and beverage sectors.

TABLE 14

AGGREGATE FRASER RIVER COMMODITY FLOWS: MODAL SPLIT (BY % OF TONNES)

	Inputs (%)	Outputs (%)	Total (%)
TRUCK	35.4	64.0	49.6
RAIL	14.1	17.1	14.5
SHIP	50.5	18.9	35.9
Total	100.0	100.0	100.0

SOURCE: from Fraser River industrial survey, 1979 and 1980

than the average) the figures represent an average of the individual modal splits (in per cent) of each firm. An analysis of these tables reveals several notable features.

Observation of the origin/destination patterns of industrial commodities (Table 12) shows that there is a high proportion of raw material inputs originating from within British Columbia. Within the sample, an average of 63.8 per cent of total inputs originated either within Metropolitan Vancouver or the rest of the province. The G.V.R.D. figure (26.5 per cent) reflects the effect of secondary manufacturing local market-oriented establishments. The large British Columbia figure (37.3 per cent) is accounted for by the wood and wood products industries (inputs of logs from the coast and interior) and non-metallic mineral industries (sand and gravel from offshore islands, copper from the interior).

The large overseas component contained within this column of inputs (20.9 per cent of total) is a reflection of the port location of the metropolis. A large segment of this import trade consists of steel shipments from Japan (and to a lesser extent from Europe) that are offloaded at public berthing facilities and transshipped to metal fabricators not on the waterfront. The market area for these fabricators is generally contained locally or, at their greatest extent, within Western Canada.

The average share of the sample firm's total production destined for the local market was 38.1 per cent,

indicating a high degree of market-orientation. However, whereas inputs were obtained almost exclusively from two sources (British Columbia and overseas), outputs were distributed more evenly over a broader range of destinations. Markets outside of British Columbia accounted for an average of 42.5 per cent of the firm's total outputs yet these areas supplied only 36.2 per cent of total inputs.

Finally, firms seem to be more import-oriented than export-oriented. Whereas a large proportion of total inputs was obtained overseas (20.9 per cent), this same overseas market accounted for less than ten per cent of outputs. In all likelihood these figures understate the actual international marine transportation linkages of resident industry because they do not include those purchases or sales from/to local merchandisers that were originally exported or imported.

As shown in Table 13, this commodity linkage pattern can be disaggregated by manufacturing type. Light manufacturers, represented primarily by the wood and wood products sector, have strong provincial input linkages (96.0 per cent of total inputs). Their output linkages are, however, principally international in nature with 43.7 per cent of outputs being exported. Heavy manufacturers, with principal representation from the metal fabricating sector, have strong input linkages overseas (28.8 per cent of total inputs). A large proportion of this figure consists of steel shipments from Japan and Europe. Their market area, on the other hand, is primarily restricted to Western Canada in general

(86.5 per cent) and the GVRD in particular (50.1 per cent).

The most notable feature of the commodity flow pattern disaggregated by modal split (table 14) is the large portion of total raw material inputs arriving by ship. For the sample of fifty firms, an average of 50.5 per cent of total cargo inputs (by weight) arrived by water. Both light manufacturers (e.g., wood and wood products industries) and heavy manufacturers (e.g., steel fabricators) received a large proportion of their total inputs by water. In the case of the former, inputs of logs in the form of booms drawn by tugs from coastal British Columbia accounted for the large figure. For the latter, the basic raw material input (steel) invariably arrived from overseas via deepsea vessels. A strong positive relationship exists between 'Percentage of Inputs from B.C.' and 'Percentage of Inputs by Ship' (Spearman's Rank Correlation Coefficient = 0.7931, significant at α = .001, for N = 19). The same relationship is apparent between 'Percentage of Inputs from rest of World' and 'Percentage of of Inputs by Ship' (Spearman's Rank Correlation Coefficient = 0.9129, significant at α = .001, for N = 19).

The principal mode of transportation for the movement of Fraser River industry outputs is by truck. Sixty-four per cent of all outputs, by weight, are moved in this way. This figure may be explained by the local/regional market orientation noted in table 12. As proof, a strong positive correlation exists between 'Per cent of Outputs by Truck' and 'Per cent of Outputs to

GVRD' (Spearman's Rank Correlation Coefficient = 0.5994, significant at α = .001, for N = 48).

Another noteworthy feature contained within this table is the diminished importance placed upon water transportation in the movement of outputs in comparison to the movement of inputs (from 50.5 per cent of total inputs to 18.9 per cent of total outputs). This difference can be explained as follows:

1. Water-oriented manufacturers require access to the waterfront for the movement of bulky raw material inputs. Under certain conditions and depending on the market being served, outputs, being in a more unitized form, may be carried more economically by road and rail. In addition, the flexibility in transportation options, necessary for the movement of outputs in order to accommodate changing market demands, favours movement by truck and rail.
2. Vancouver's position as a regional port city serving a Western Canada hinterland necessitates the movement of a large quantity of manufactured products inland.
3. Manufacturing within Metropolitan Vancouver also carries out the important function of serving the local market. The short haul trips associated with the distribution of these products does not favour water transportation.

Parallels may be drawn between these linkage patterns and those existing in other metropolitan industrial communities. Ferguson (1982), in a recently

completed research paper, produced a comparable linkage analysis of the industrial community at Hamilton. Surprisingly, given the geographic and market location differences, many of the spatial linkages at this Canadian heartland city correspond closely with those at Vancouver.

Provincial industrial input commodity linkages with Hamilton industry accounted for 58.6 per cent of total input linkages (compared with 63.8 per cent for Fraser River industry) and similarly, output linkages within the province were 60.1 per cent of total outputs (compared with 57.4 per cent for this study). The only major difference in commodity linkage patterns between the two study areas is with respect to international linkages. Whereas Fraser River manufacturers had substantial linkages overseas (20.9 per cent of inputs and 9.7 per cent of outputs), Hamilton manufacturers had a much smaller overseas component (1.7 per cent of inputs and 2.7 per cent of outputs). At least part of this difference may be accounted for by Vancouver's favoured position as a western coastal port. Transport costs at a coastal port location are lower than at an inland port site, where an additional charge for the rail or seaway link to the interior must be included in the total transport cost. This supplemental charge may be sufficient enough to discourage movement by ship.

The modal split for the transport of inputs was also similar between the two industrial districts. However, when modal split is examined with respect to outputs, a marked difference is apparent. A much greater

share (79.3 per cent) of total output traffic is moved via truck for the Hamilton firms (compared with 64.0 per cent for the Fraser River industry). This difference is attributable to two phenomena: a greater proportion of destinations in Southern Ontario within a one-day travelling distance from Hamilton and the prominent position held by vessel travel (for export shipments) within the Fraser area. Whereas Fraser River firms moved an average of 18.9 per cent of outputs by ship, Hamilton firms transported only 4.3 per cent of outputs by this mode.

Fraser River Industrial Linkages and Decentralization

Commodity flow patterns of Fraser River industry (tables 12, 13 and 14) suggest that local commodity linkages are not strong enough to force manufacturing activity to locate downtown. It seems that, although Metropolitan Vancouver input linkages (26.5 per cent of total) and output linkages (33.1 per cent) constitute a large proportion of total linkages, minor variations in distribution costs throughout the metropolis are responsible for the footloose nature of suburban manufacturing. In addition, these figures represent linkages within the entire G.V.R.D. (and beyond, given the error factor in delimiting the metropolitan market area), not solely within the central city. Because 73.5 per cent of input linkages and 61.9 per cent of output linkages are outside of Metropolitan Vancouver a central city location is not the crucial factor in the locational decision of the firm.

Admittedly, this analysis examines material linkages only, thereby disregarding the administrative or information linkages of the firm. Although difficult to measure, these linkages are probably concentrated to a greater degree within the central city of the GVRD However, the importance of these central city linkages, given the current trends towards preplanned and serviced suburban industrial parks, standardization of commodity linkages, and internationalization of existing economies of scale, may be exaggerated for firms engaged in routine manufacturing functions.

Locational Characteristics: Fraser River Industry

Representatives of sample firms were asked the factors responsible for the choice of this site for their operations. One hundred and eighteen responses were received from forty-nine firms (ranking multiple responses according to positions of importance may have biased the results). These are tabulated on table 15. Two related factors, 'Room for Expansion/Land Availability' and 'Low Land/Leasing Costs' (16.1 per cent of total responses each) proved to be the principal reasons for the selection of the Fraser River sites. Both of these factors relate directly to the variation in land costs between these and other metropolitan sites to explain the site decision-making process.

Because the open-ended question used to achieve these results was asked without prompting, some responses reflected the macro-locational viewpoint (i.e., selection of Metropolitan Vancouver as a site rather

TABLE 15
FRASER RIVER INDUSTRY LOCATIONAL CONSIDERATIONS

	No. of Responses	%
Room for Expansion/Land Availability	19	(16.1)
Central Market Location	19	(16.1)
Low Land/Leasing Costs	19	(16.1)
Access to Waterfront/ Port Facilities	18	(15.3)
Existing Buildings/ Facilities	7	(5.9)
Transport Modal Flexibility	7	(5.9)
Access to Labour Supply	7	(5.9)
Proximity to Raw Materials/Suppliers	5	(4.2)
Low Tax	3	(2.5)
Other Reasons	14	(11.9)
Total	118	(99.9)

SOURCE: from Fraser River industry survey, 1979 and 1980

NOTE: The 118 responses were received by forty-nine firms.

than elsewhere in British Columbia) rather than the micro perspective (i.e., Fraser River site instead of elsewhere in Metropolitan Vancouver). This explains the large number of responses given to 'Central Market Location' (19 or 16.1 per cent) and 'Access to Labour Supply' (7 or 5.9 per cent). Together with those responses noting site size and cost characteristics was the importance of 'Access to Waterfront/Port Facilities' (18 responses or 15.3 per cent of the total). Significance of access to the Fraser River and water transportation in general is reflected in this response.

Locational Considerations of Decentralizing Firms

As noted previously, increasing industrial activity in the suburbs is attributable to the birth of new companies in the area and the movement of existing companies to the area. The Fraser River industrial sample consists of 24 firms (48 per cent) of the former and 26 (52 per cent) of the latter. Most of those firms relocating to this study area had a previous location elsewhere in Metropolitan Vancouver. This constitutes the decentralizing group.

The overwhelming factor involved in the relocational decision for this decentralizing group was a lack of room for expansion at their previous location. Fifty-six per cent of this group stated this to be the principal factor in their movement. This points directly to the suburban land availability advantage and indirectly, through the level of competition for availability of additional central city property, to land cost

differences between the city and suburbs.

In order to determine whether a significant difference in characteristics exists between those firms that had relocated from elsewhere within the GVRD to this site (i.e., decentralized) and those firms that chose this site to set up a new operation, a crosstabular analysis using these two groups was conducted. Relocating firms showed significant differences in the following personal, site, and linkage characteristics.* They were located on smaller sites, required fewer inputs, leased their sites, and had greater material linkages within the GVRD and fewer material linkages outside of Metropolitan Vancouver (i.e., local market oriented), than had the newly established or original occupant firms. In addition, those that located at the Fraser River site after an intrametropolitan move had a proportionately greater tendency to utilize truck transport in place of water transportation.

The divergence in characteristics of the two groups is most likely attributable to a change in form of industrial development, from owner built and operated single plot developments to the leaseheld, fully serviced industrial park design. Relocating firms moving to the area are gravitating towards preplanned industrial parks (e.g., Annacis Island Estates, Tilbury Island Estates). The creation of these parks have allowed for the movement of inner city firms to

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*Significant to alpha equals .05 with 1 Degree of Freedom using Two Sample Chi Square tests.

the suburbs earlier in their incubation period so that they may take advantage of the fixed capital cost savings at these locations while retaining some external economies of scale, and an associated local market linkage pattern.

Trends: Industry and the Fraser River

Using the data gathered on existing firms, forecasts can be made with respect to the future form and extent of industrial development within the study region. The relationship depicted in table 16 suggests that recent suburban growth (within the last ten years) is more a function of the process of decentralization than of the birth of new industry. This supports the incubator hypothesis held by Lonsdale and creates an important marketing tool for the development of suburban industrial estates.

To determine whether significant statistical associations exist between the age of the firm and the firm's character profile (i.e., an indicator of trends), nonparametric correlation coefficients were used (i.e., ordinal data). The results (table 17) indicate that the newer a plant, the smaller its size in terms of site area, number of employees, and total inputs required/outputs produced.

Although it has been noted that firms within the study region are becoming increasingly oriented towards the local region, a distinction must be made with respect to the patterns of forward (output) and backward

TABLE 16
CROSSTABULATION - ESTABLISHMENT DATE AND PREVIOUS LOCATION

Previous Location	Before 1970	1970-1980	
No Previous Location	17[a] (35.4)[b]	6 (12.5)	23 (47.9)
Elsewhere within GVRD	11 (22.9)	14 (29.2)	25 (52.1)
Total	28 (58.3)	20 (41.7)	48 (100.0)

Chi Square Value = 4.41004 (1 Degree of Freedom)
Significant to 0.0357

SOURCE: from Fraser River industry survey, 1979 and 1980

[a]represents number of firms in each category
[b]( ) denotes percentage of total number of firms (48) in sample

TABLE 17
NONPARAMETRIC CORRELATIONS - FRASER RIVER INDUSTRIES

Correlated Variables[a]	R Value[b]	Significance Level
AGEFIRM with SIZESITE	-0.2977	.020
AGEFIRM with EMPLOYEE	-0.4573	.001
AGEFIRM with TOTIN	-0.2902	.024
AGEFIRM with TOTOUT	-0.2783	.029
AGEFIRM with WRLD%IN	-0.4758	.020
AGEFIRM with WRLD%OUT	-0.4512	.061

SOURCE: from Fraser River industrial survey, 1979 and 1980

[a]a description of these variables is contained within appendix II

[b]Spearman's ranked correlation coefficients were employed in this analysis; for purposes of clarification of patterns, where a value of zero (0) appeared for a case that specific case was eliminated from the statistical analysis

(input) linkages. The above table indicates that newer firms have significantly greater input linkages overseas and smaller overseas output linkages (exports).

This information, combined with the apparent differences in linkage patterns between light and heavy manufacturers, provide evidence that the trend in functional type of industrial growth in the region is stronger in the heavy manufacturing group (e.g., metal fabricators, etc.; see complete list on table 9) than in the traditional wood processing sectors that comprise most of the Light manufacturing group.

Table 18 presents a positive view of the prospects for industrial development within the study area over the next five years. A large proportion of firms (60 per cent) indicated that they had definite plans for expansion, mainly within the same study area. Very few firms (8.0 per cent) indicated that they were planning to migrate from the study region within this five-year planning period.

Site and Linkage Characteristics: Non-Port Versus Port Industry

Port and non-port using industries can be differentiated by a number of characteristics. This stage of the analysis is conducted in order to provide insights into the nature of waterfront industry along the Fraser River, with the objective of determining differing locational factors associated with port and non-port industry.

TABLE 18

FRASER RIVER INTERNAL INDUSTRIAL GROWTH POTENTIAL

	No. of Firms	%	Location
Expansion	22	(73.3)	- within Fraser River study area
	8	(26.7)	- outside Fraser River study area
TOTAL	30	(50.0)	
Relocation	0	(0.0)	- within Fraser River study area
	4	(100.0)	- outside Fraser River Study area
TOTAL	4	(8.0)	
Neither	16	(32.0)	

SOURCE: from Fraser River industrial survey, 1979 and 1980

NOTE: The range for these alternatives is five years.

The most notable distinction that can be made between port and non-port firms is in their relative size. Those firms located on the waterfront and using the river for the shipment of cargo are significantly larger than non-port firms. Size, in this case, refers to number of employees, size of site, book value of plant, and quantity of inputs/outputs. The economies of scale associated with water transportation dictate that the larger firms are going to require greater access to this mode of transportation. In addition, from these relationships it can be concluded that port related firms are in the best position to utilize the hypothesized fixed capital cost advantage existing in the suburbs as shown by their larger site areas and greater book values.

Port users cannot be differentiated significantly in terms of their functional type. However, the group classified heavy manufacturing (e.g., metal fabricating, non-metallic minerals) is associated with the non-port using group. Although this group contains several activities dependent upon water access (e.g., cement and concrete products and chemical industries) the majority of firms contained within this group are not located on the waterfront and rely upon truck transportation for the movement of the largest proportion of their commodities. The port group is generally associated with the light manufacturing category, composed primarily of wood and paper products industries. Marine transportation input linkages within this group involve the movement of logs; output linkages are associated with the movement of finished lumber products

and wood chips/sawdust.

The linkage patterns of the port/non-port groups resemble closely the distinction that was made with respect to linkage patterns in terms of functional classification (table 13). Port users have a significantly greater share of total inputs (bulk raw materials) originating at the provincial level. The destination linkages are strong internationally (representing basic industries). Therefore, both forward and backward commodity linkages are not strongly influenced by the metropolitan market and a location at the focus of this metropolitan market (i.e., Burrard Inlet) is not essential.

What emerges then is a fundamental distinction in site and linkage characteristics, and therefore in locational considerations, between the port and non-port related groups of industries. The linkage patterns of non-port firms are still heavily influenced, indirectly, by the metropolitan port location. This is proved by the fact that although these firms do not have port facilities they do have a strong international commodity input pattern. Therefore they rely upon the public docking facilities. However, their output linkages are oriented towards the local market. The characteristics described seem to indicate that this is the direction in which manufacturing development is moving. Although the degree to which firms are utilizing the Fraser River directly is declining, indirect use of the river as a medium of transport, through central docking facilities, is increasing in importance.

CHAPTER 5
MACRO-INDUSTRIAL LOCATION FACTORS IN METROPOLITAN VANCOUVER

The previous chapter presented a descriptive synopsis of industry within the Fraser River study area. Specifically, it examined the commodity linkage patterns of resident industry. Proceeding from this point, this chapter identifies the existence and spatial variability of the factors of production at the metropolitan scale. The factors of capital (in the form of site costs) and labour (in the form of wages paid to employees) are examined. In addition, a general index of the capital/labour ratio for industry within each municipality of Metropolitan Vancouver is obtained to determine whether there exists a spatial pattern of varying industrial capital intensity throughout the metropolis.

Industrial Land Prices: Metropolitan Vancouver

As has been noted, several research efforts have concluded that industrial land prices decrease as the distance from the city centre increases. This inverse relationship exists and is more pronounced within Metropolitan Vancouver because, among other reasons, there is an inefficient central city-suburb expressway system and a concentrated local residential and commercial market.

Figures 6 and 7 show the differences in industrial land prices at all of the major metropolitan industrial

Figure 6: AVERAGE INDUSTRIAL LAND PRICES PER ACRE IN METROPOLITAN VANCOUVER, ONE ACRE OR LESS, 1980 *

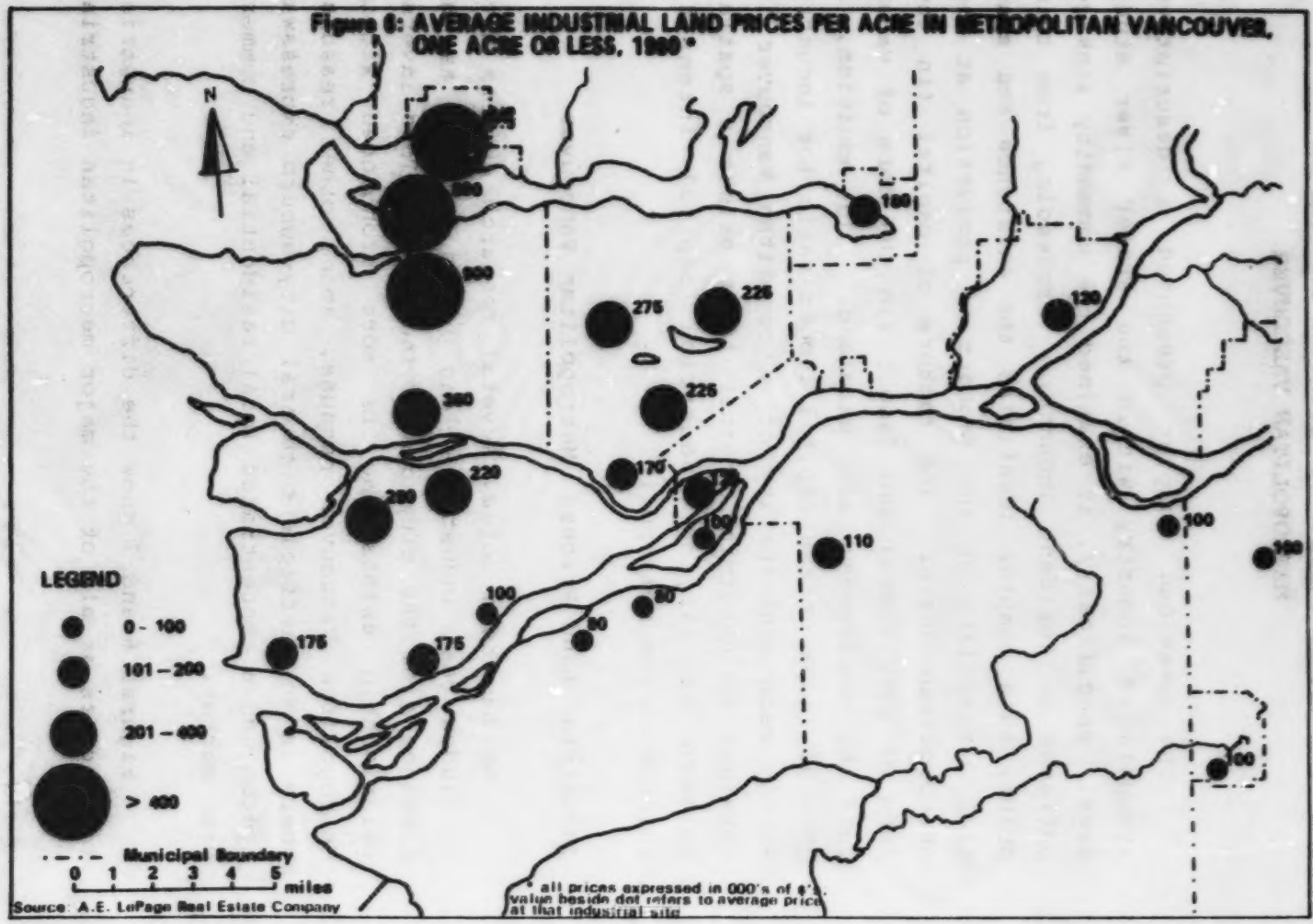
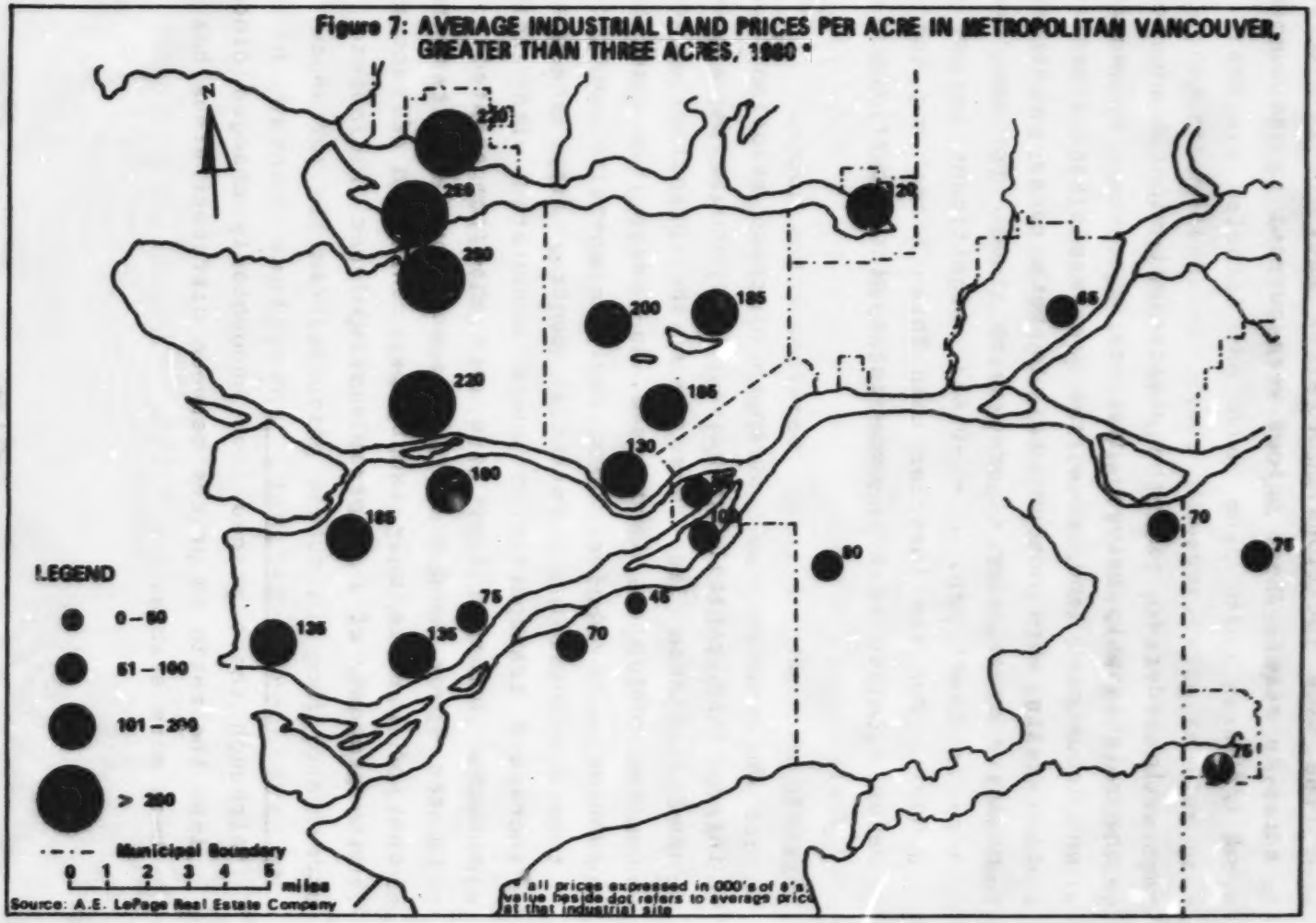


Figure 7: AVERAGE INDUSTRIAL LAND PRICES PER ACRE IN METROPOLITAN VANCOUVER, GREATER THAN THREE ACRES, 1980 *



sites. Figure 6 shows the average land price for sites one acre or less in size. Figure 7 shows land prices, at the same locations, for sites greater than three acres in size. These prices were current to the summer of 1980.

In order to test the statistical significance of the relationship between distance from the city centre and industrial land price, two Spearman's Rank Correlation tests were conducted. In both cases, a strong negative correlation figure was obtained. For the 'One Acre or Less' map, $r = -0.814$, significant to $\alpha = 0.0001$. For the 'Greater than Three Acres' map the r value equalled -0.839, once again significant to $\alpha = 0.0001$.

The existence and strength of these relationships infers that capital-intensive firms should be attracted to those locations where the principal fixed capital cost item, land costs, is lowest (i.e., in the suburbs). Even for those capital-intensive manufacturers maintaining substantial central city linkages, increased transportation costs associated with their suburban location have been more than compensated for by the lower land costs (at some suburban sites the cost of land is only twenty per cent that of central city property of a comparable size).

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*Although these prices have undoubtedly changed since 1980 the ratio in prices between different areas has been more stable.

Lower property costs at suburban GVRD sites are in part a reflection of increased site preparation costs. Site preparation takes the form of land filling, servicing, etc. Where large, undeveloped parcels of land are selected the owner must often assume a large proportion of these costs. However, with smaller properties, as in suburban industrial parks, the developer/owner or municipality frequently assumes responsibility for initial site preparation and, in doing so, is able to amortize the associated costs to the tenants over a number of years, thereby maintaining fairly low land costs.

Labour Costs: Metropolitan Vancouver

Labour and associated costs, in the form of wages paid to employees, complement capital as a factor of production. If as is hypothesized, labour costs for similar occupations vary within the metropolis in response to local labour demand and supply, then labour-intensive firms will gravitate to those locations where labour costs are lowest.

The following analysis of industrial wage rate variations within Metropolitan Vancouver is conducted at two levels. First, an aggregate examination is presented, showing the variation in average annual wages for all manufacturing production positions listed in branch employment agencies throughout the

GVRD* Second, a disaggregated analysis of two specific occupational categories, textile production workers and general office clerks, are shown to note spatial variations.

Two potential problems present themselves with this investigation. The first problem is that wage rates are not comparable within the metropolis because these wages incorporate varying levels of skill, as reflected in the form of training and experience (seniority) pay increments, merit pay, and commission. This problem has been avoided by utilizing wage data that are relatively free of these influences. Positions listed in employment offices emphasize starting salaries, independent of subsequent differential increases.

A second problem, primarily with specific occupational categories, involves the maintenance of a representative sample size. Potential bias produced from a small sample prevented the presentation of more than the two occupational categories mentioned. There were no fewer than fifteen observations in each of these two categories.

An argument can be raised to the effect that the aggregate form of wage rate measurement, involving all

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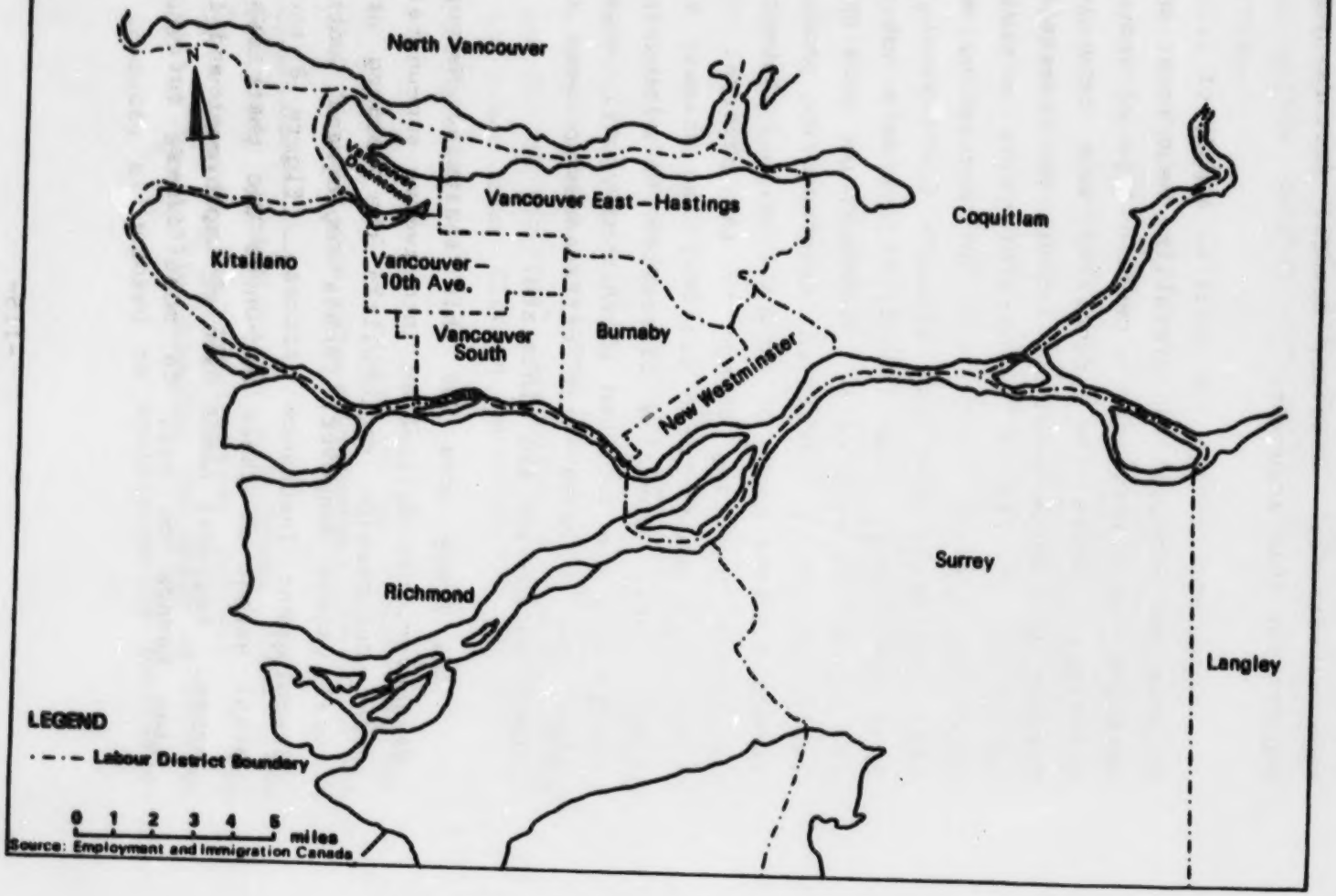
*manufacturing production = all those occupations adding value to the manufactured product in the process of physically changing the shape or form of the product, as opposed to administrative functions.

production functions listed, measures the industrial mix of various municipalities rather than metropolitan wage variations. However, several factors decrease support for this argument.

Most importantly, the relative supply of labour in an area has produced the prevailing wage rates thereby creating the climate for a certain type of industrial activity. Where the prevailing wage rate is low because of a large supply of labour, the industrial mix is going to favour labour-intensive activities. Increasing demand for labour (or decreasing supply) will produce an area more suitable for capital intensive activities. The industrial mix does not create the prevailing wage rate. Secondly, and more specifically, that group classified 'manufacturing production' covers a narrow range of occupations, all characterized as labour producing change to the physical form or shape of a manufactured product. No primary or tertiary (i.e., generally classified as administration) occupations are included in this category. Because of this, the characteristic differences between occupational categories are minimized.

The study area for this analysis, Metropolitan Vancouver, was delineated into twelve sub-units. This areal delineation regionalizes the working areas of local Canada Manpower, Canada Employment Centre, and Unemployment Insurance offices. Figure 8 shows the areal extent of these sub-units and their associated names. Regional names used by Employment and Immigration Canada do not, in most cases, correspond to

Figure 8: CANADA MANPOWER CENTRE LABOUR DISTRICTS IN METROPOLITAN VANCOUVER, 1980*



municipal names and boundaries. For purposes of maintaining an adequate sample size in analyzing the disaggregated occupations (textile employees and general office clerks) three pairs of contiguous sub-units were amalgamated: New Westminster-Coquitlam, Surrey-Langley, and Burnaby-Vancouver South.

Table 19 reveals that the average annual wages offered to starting manufacturing production employees is significantly less in the central city (i.e., Vancouver Downtown) than in the surrounding areas. In Richmond and New Westminster the average wage is seventeen to twenty-one per cent greater than Vancouver Downtown.

Figure 9, in a generalized representation of this information, reveals the general pattern of increasing wages with increased distance from the city centre. Corresponding closely with the findings of Scott (1979) for Toronto, and Hoover and Vernon (1959) for New York, the following pattern is observed. Wages paid increase gradually from the city centre to the outlying suburbs (Richmond, New Westminster) at which point they begin to decrease once again (Langley, Coquitlam). However, within these outlying districts the prevailing wage rates still remain higher than at the city centre.

The variation in wages between adjacent districts connected by an efficient urban road network are minimized because travel time, as a measure of mobility of workers, is reduced. From the map, wage rates do not vary significantly in those regions running east-west

TABLE 19

AVERAGE ANNUAL EARNINGS OF MANUFACTURING PRODUCTION EMPLOYEES IN METROPOLITAN VANCOUVER IN RELATION TO DOWNTOWN VANCOUVER EMPLOYEES, 1980

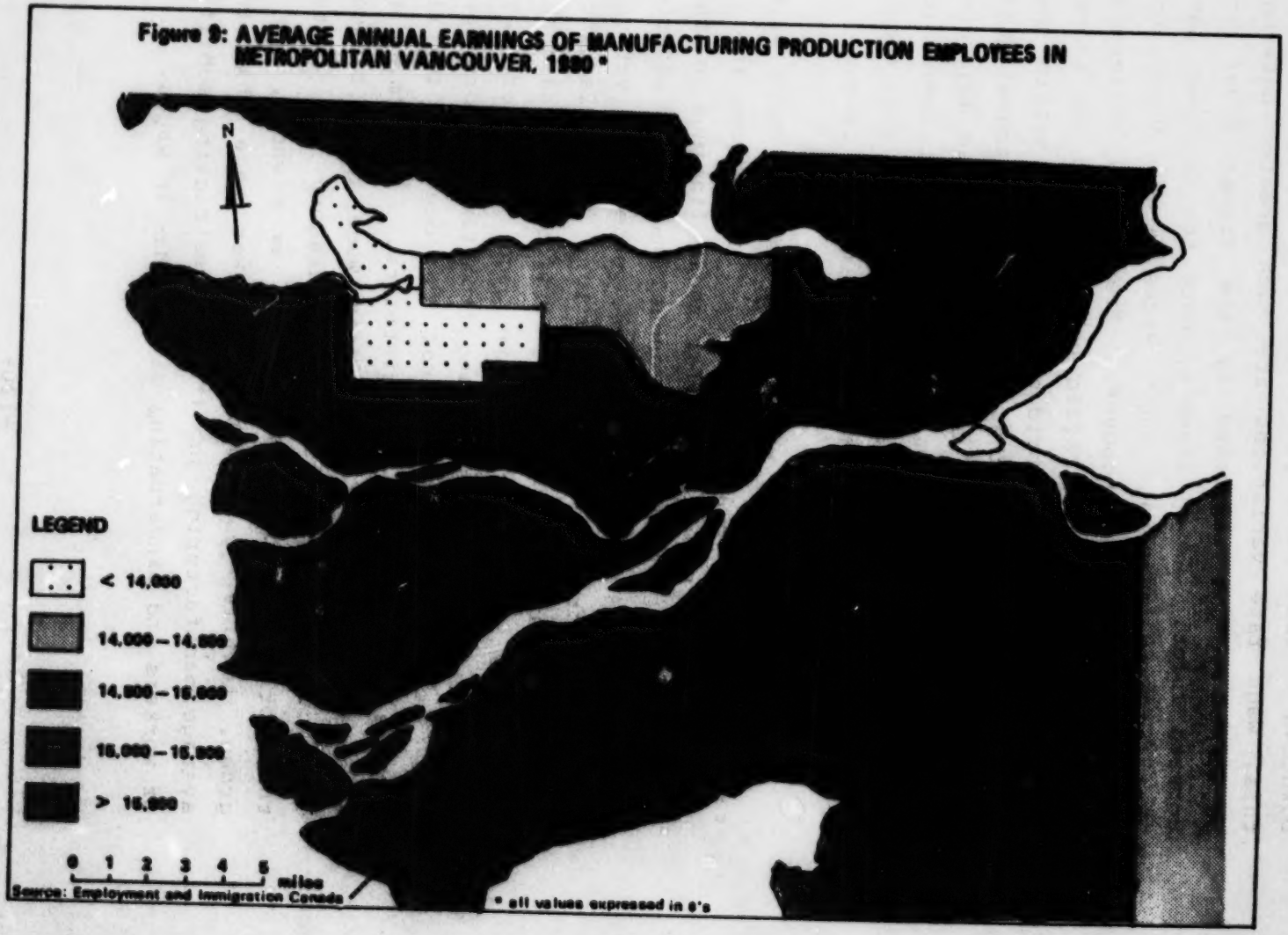
Employment District[a]	Annual Earnings ($)	% of Downtown	N[b]
Vancouver Downtown	13,477.68	100.00	243
Vancouver 10th Ave.	13,834.20	102.65	405
Vancouver E. Hastings	14,140.56	104.92	335
Kitsilano	14,521.08	107.74	155
Vancouver South	14,679.36	108.92	131
Burnaby	14,890.32	110.48	173
North Vancouver	15,424.20	114.44	321
Richmond	15,841.92	117.54	425
New Westminster	16,329.36	121.16	149
Surrey	14,782.08	109.68	464
Coquitlam	14,585.04	108.22	252
Langley	14,263.08	105.83	139

SOURCE: as represented by listed positions at local Canada Employment Centres over a four-month period, March-June, 1980

[a]These districts and their associated names correspond to the working regions of Canada Employment Centres or Unemployment Insurance Centres. The areal extent of each is shown on Figure 8.

[b]N = the number of individual observations in each areal unit classified as manufacturing production positions

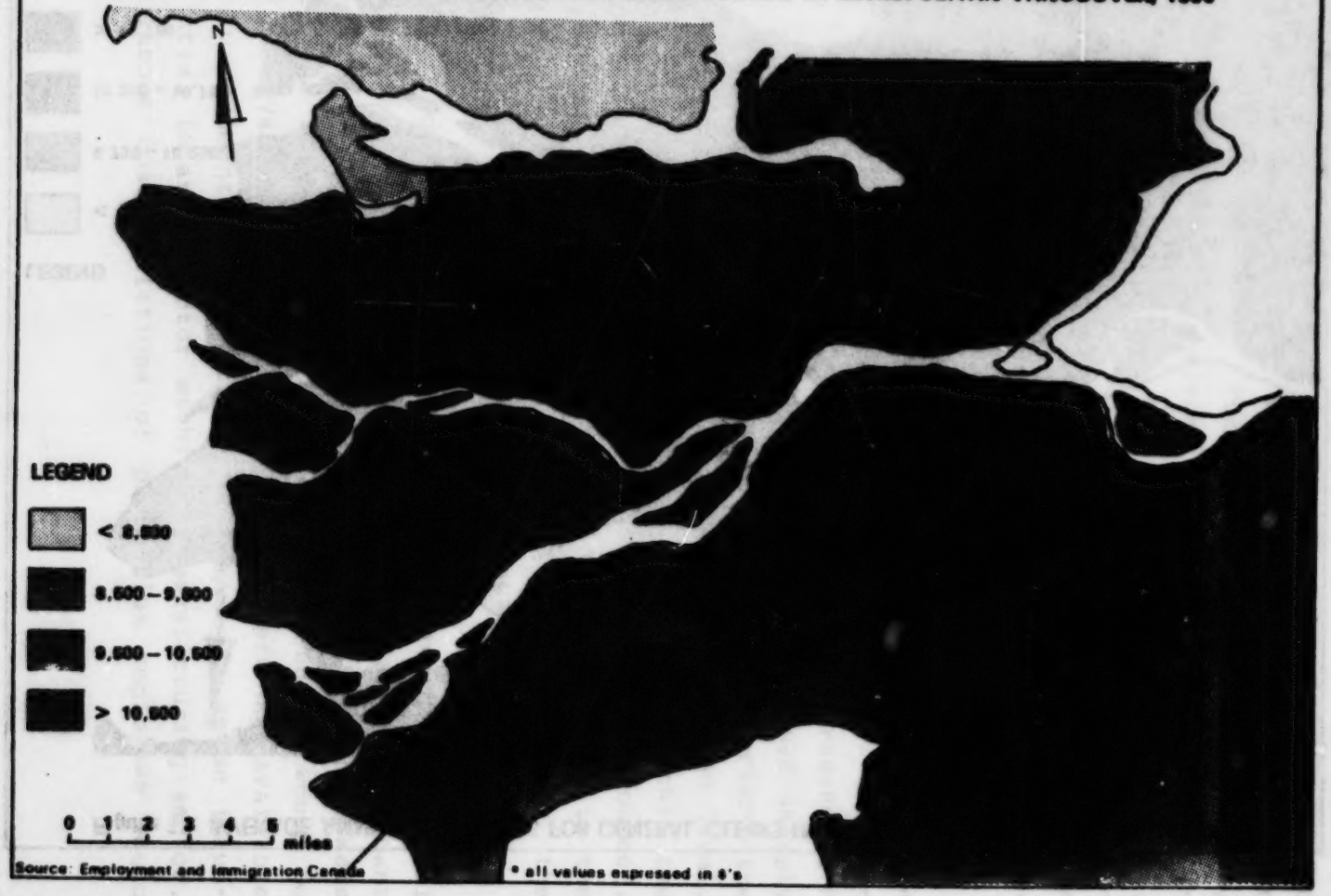
Figure 9: AVERAGE ANNUAL EARNINGS OF MANUFACTURING PRODUCTION EMPLOYEES IN METROPOLITAN VANCOUVER, 1980 *



along the south shore of Burrard Inlet (Vancouver Downtown - East Hastings - Coquitlam). Contrasting this, wage rate variations are much greater between adjacent regions separated by the Fraser River or Burrard Inlet. As an example, note the fourteen per cent increase in average annual wages between Vancouver Downtown and North Vancouver. Presumably, increased travel time caused by traffic congestion at the Lions Gate Bridge (and other bridges and tunnels within the metropolis) increases the real cost of travel and hampers the mobility of workers between these adjacent districts. As a result wages paid to attract labour to these less accessible locations reflect the added travel costs associated with the movement of labour.

Figures 10 and 11 provide examples of these wage rate variations disaggregated by specific occupation. Generally, the results parallel those findings at the aggregate level. The average annual wage rates offered for the textile occupations were especially variant across the metropolis (see figure 10). Those districts most closely representative of the labour surplus inner city zones (Vancouver Downtown and Vancouver East Hastings) offered wages ranging from five to forty per cent lower than those offered to potential textile workers in the peripheral districts. Conforming to expectations, the differences in wage rates between districts for this occupational category are greater than for manufacturing occupations as a whole. As a group, textile jobs command a lower wage than the average manufacturing job thereby restricting mobility of workers and exacerbating differences in wages.

Figure 10: AVERAGE ANNUAL EARNINGS FOR TEXTILE WORKERS IN METROPOLITAN VANCOUVER, 1980*



Source: Employment and Immigration Canada

* all values expressed in $'s

Figure 11: AVERAGE ANNUAL EARNINGS FOR GENERAL CLERKS IN METROPOLITAN VANCOUVER, 1980 *

Unexpected spatial variations do however occur between this occupational category and the aggregate manufacturing category. For example, wages offered within North Vancouver are approximately the same as in Vancouver Downtown. For all secondary manufacturing employment, there exists a pronounced difference in wages between these two districts. In addition, whereas the aggregate classification showed a significantly greater prevailing wage rate in Richmond, in relation to adjacent districts for textile occupations, Richmond workers command a smaller prevailing wage.

These anomalies may be explained by virtue of the lower wages and mobility of textile workers. In addition, for the aggregate analysis, wages increased with distance from the city centre and then declined sharply in the outlying districts. For textile workers the same relationship exists at a more concentrated level. The variation in wages between areal units within the City of Vancouver and Burnaby is more pronounced. Beyond this, wages began declining dramatically in the districts of Richmond and Surrey rather than the outlying areas of Coquitlam and Langley.

For those higher paid administrative or managerial occupations, where travel costs are a less significant portion of total disposable income, mobility of workers would be greater and the wage rate gradient would be less variable. Unfortunately, data were not available to document this relationship. However, as an industrial location factor within the manufacturing sector, labour cost variations of production employees would

be more significant than administrative employees at the firm. For those sectors with a greater proportion of administrative employees (e.g., wholesaling, transportation and communications) it is expected that labour cost differentials at the metropolitan scale would have a smaller effect upon location.

One example of administrative occupations, although not of the managerial/professional class, is presented here. Figure 11, depicting the variation in average annual wages for general office clerk positions listed at employment offices throughout the GVRD, shows a general parallel with that of aggregate manufacturing occupations (figure 9). Wages offered increase gradually with distance from the labour surplus areas, although this variation is not as significant as in the textiles occupations example (e.g., a maximum difference of only twenty-one per cent in wage rates as opposed to forty per cent for textile workers at different locations).

One major anomaly from the hypothesized pattern of wage rate variations exists with this specific occupation. There is a relatively high prevailing wage rate offered within Vancouver Downtown. This case may be a result of sample bias within the inner city group of employees or a reflection of actual differences in wage rates. Whatever the cause, the effect upon the relocation of manufacturing industries is considered minimal.

Both individual occupational wage maps exhibit some deviations from the expected pattern. These wage

irregularities can be attributed to a number of factors including, to a limited degree, the level of unionization, specific company policy and tradition, level of fringe benefits, and mix of industry. However, when all manufacturing sectors have been amalgamated, as in figure 9, the direct correlation with wages paid and distance from the inner city is unmistakable. Also, the detrimental effect of river barriers on the movement of labour, in the form of increased travel constraints at bridges and tunnels, is reflected in the relatively large wage rate differences in adjacent districts separated by the Fraser River and Burrard Inlet.

The effect of these spatial variations in wage rates on industrial relocation is to influence labour-intensive activities to move to inner city locations where higher land costs can be offset by labour cost savings. Conversely, capital-intensive activities will adopt land-extensive production techniques in peripheral areas where higher labour costs are more than offset by lower land costs. Those areas with higher labour costs would be expected to have a greater proportion of highly capital-intensive industry. With respect to decentralization, the general trend towards capital intensification of industrial activity as a whole has prompted the movement of industry from the high capital cost areas (inner city) to the low capital cost areas (suburbs) of the metropolis.

The combination of these two forces (labour cost advantage in the inner city and capital cost advantage

in the suburbs) should produce a zonal system of industrial activity, with industry becoming more capital intensive as it radiates outward. Some of the following factors would distort this pattern: differential levels of accessibility (e.g., an urban expressway, rivers spanned by few crossings), the quantity of industrial land available within the inner city, and the supply of and demand for local labour (population and industrial decentralization). However, although these factors may affect the gradient of capital intensification with distance from the city, the basic direct relationship is maintained.

Industrial Capital/Labour Ratio: Metropolitan Vancouver

Using Statistics Canada aggregate reports and the British Columbia Manufacturing Directory - 1979, the following analysis determines the industrial mix of Metropolitan Vancouver by means of a capital/labour intensity ratio representing industrial types within each G.V.R.D. municipality. This ratio, developed and used at a regional scale to differentiate between the industrial composition of Quebec and Ontario by Norcliffe and Stevens (1979), may be applied at the metropolitan scale as well.

The formula used to determine any industry's capital/labour ratio is, "for any industry, i, in any region, j, we define the ratio as

$$CL_{ij} = (VA_{ij} - W_{ij}) / E_{ij}$$

where VA represents value added, W represents production wages, and E represents the number of production employees." (Norcliffe and Stevens, 1979, 247). Value added was seen to be a suitable indicator of capital investment, being defined as gross output of the industry less the cost of materials, supplies, fuels, electricity, and wages (W).

The value added, wages paid, and number of employees, are presented in aggregate form for every manufacturing sector (except where the small number of firms would breach confidentiality rules) to the three-digit Standard Industrial Classification level. Contained within Statistics Canada (1978) documents disaggregated to the provincial level, each manufacturing industry was assigned a per capita capital/labour intensity figure (i.e., the amount of value added per employee) (see appendix III). Although provincial figures were the most disaggregated form of data available their applicability at the metropolitan scale was considered appropriate because of the high degree of provincial industrial concentration within the GVRD.

A random sample of 75 manufacturing firms from each municipality within the GVRD was selected from the British Columbia Manufacturing Directory - 1979. In addition, in order to obtain a more accurate estimate of the variation in industrial capital intensity within the central city, the City of Vancouver was disaggregated into a 'Central Core' area (bounded by Commercial Dr. and Granville St. in the east and west, Broadway

Ave. and Burrard Inlet in the south and north) and the rest of the city (see figure 12).

The values, listed on table 22 and displayed on figure 12, represent the mean capital/labour intensity measure per employee for the sample of 75 firms from each of the municipalities. In effect, the average manufacturing firm within the central core had added value of $18,814.40 for each employee. In comparison, manufacturing firms were seen to be much more capital intensive in Port Moody, with an average value added of $37,831 per employee.

The pattern of capital intensity of industrial activity (figure 12) conforms to the expectations when the metropolitan land cost and aggregate wage level patterns are reviewed. The most labour-intensive industrial area is the central core of the city, where labour costs are lowest and land costs are highest. The capital component in manufacturing increases with distance from the city peaking in Delta, New Westminster, and Port Moody. In these areas, aggregate wage rates are highest, influencing firms to minimize their labour inputs, and land costs are significantly lower, promoting the use of capital-intensive land-consuming production techniques.

Beyond this suburban zone, resident industry has a stronger labour component. Although labour costs do begin to decline once again, other factors are more likely causing the increased reliance upon labour in these outlying areas. Because of higher transport

TABLE 20
PER CAPITA MANUFACTURING CAPITAL INVESTMENT IN METROPOLITAN VANCOUVER, 1978

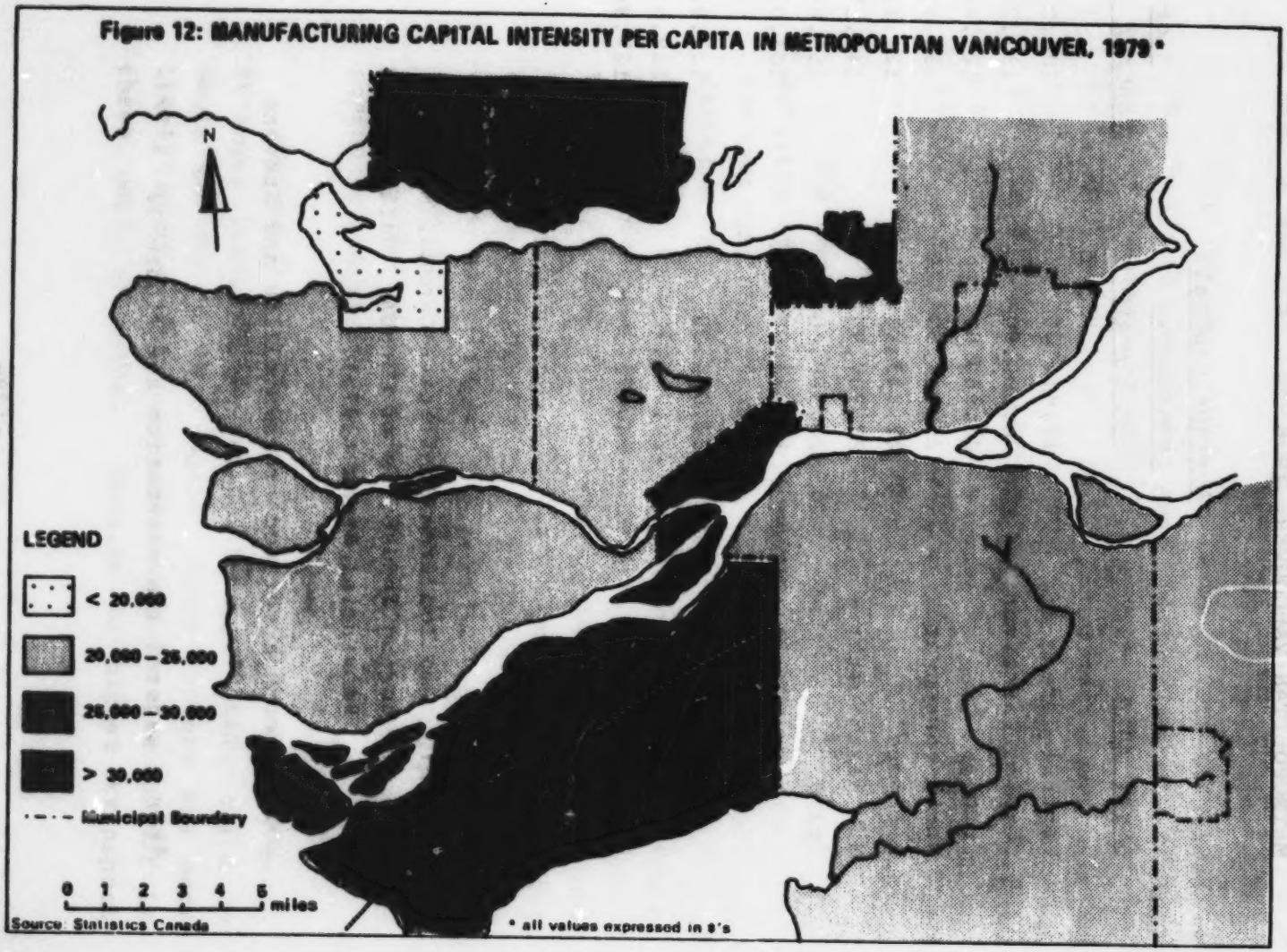
Areal Unit	Average Capital Investment/ Employee($)[a]	% of Central Core
Central Core	18,814.40	100.0
City of Vancouver	24,690.90	131.23
Burnaby	23,980.00	127.46
North Vancouver	25,341.50	134.69
Richmond	22,823.20	121.31
New Westminster	27,707.90	147.27
Delta	28,389.00	150.89
Port Moody	37,831.00	201.07
Coquitlam/ Port Coquitlam	24,064.50	127.90
Surrey	24,366.70	129.51
Langley	24,071.80	127.94

SOURCE: compiled from Statistics Canada, Manufacturing Industries of Canada: National and Provincial Areas (1978)

NOTE: formula derived from Norcliffe and Stevens (1979)

[a]For a general representation see figure 12

Figure 12: MANUFACTURING CAPITAL INTENSITY PER CAPITA IN METROPOLITAN VANCOUVER, 1979*



costs brought about by distance from the Vancouver market, resident industry is operating on a smaller scale serving the local area. As a result, shorter production runs and smaller establishments form the basis of a more labour-intensive manufacturing profile.

CHAPTER 6

SUMMARY AND CONCLUSIONS

In order to assess the influence of certain locational factors on the decentralization of manufacturing to the Fraser River industrial community, two analyses were conducted. The first consisted of a detailed examination of this suburban industrial community so that the transportation linkages (and other distribution costs) and agglomerative forces could be assessed. This investigation revealed certain similarities and dissimilarities amongst resident industry with respect to functional type, commodity linkage pattern, locational history, and site characteristics.

The second stage of this study, conducted at a macro-scale, consisted of an examination of capital and labour cost differences within the Greater Vancouver Regional District so that inferences could be made with respect to their applicability to the process of decentralization. It was observed that the principal fixed capital cost item of the industrial firm (land costs) and labour costs were spatially variant within the metropolis. The application of an index of capital/labour intensity to manufacturing within Metropolitan Vancouver confirmed that capital-intensive manufacturing activities were predominantly located in the suburbs while labour-intensive manufacturing activities were concentrated within the inner city industrial districts.

Fraser River Industrial Profile

From a sample of 50 industries (42 manufacturers) within the Fraser River study area the following general data were obtained. Manufacturing within the area was functionally diverse, although representation from the wood products and metal fabricating sectors exceeded that of other manufacturing sectors. Size of firm, as measured by site area, employment, and annual production, exceeded that of inner city industrial communities. Because of the recent nature of the phenomenon of decentralization it was expected that the date of establishment of firms would have been later than the mean of mid-1964. However, a distinction between two groups of firms (an older owner-held, single plot, waterfront group and a newer, lease-held, suburban industrial park group) contributed to the establishment of this average.

Industrial growth at this community was attributable to the immigration of existing firms (52 per cent) and the birth of new firms (48 per cent). Because the previous location of this former group was almost exclusively elsewhere in Metropolitan Vancouver, they are considered to be the decentralizing group. Within this decentralizing group the overwhelming factor prompting relocation (56 per cent) was a lack of space for expansion at their previous location.

A variety of specific locational factors were mentioned by the respondents including 'Low Land/ Leasing Costs' (16.1 per cent), 'Room for Expansion/

Land Availability' (16.1 per cent), 'Central Market Location' (16.1 per cent), and 'Access to Waterfront/ Port Facilities' (15.3 per cent). The prominence given to land cost and proximity to the waterfront suggests these are significant general location factors.

Marine Transportation Linkages

An essential objective of this study was to determine the influence of a suburban port on the growth of industry. To that end, information on the firm's marine transportation linkages was gathered. From the sample of fifty firms, thirty (60 per cent) were located on the waterfront. This represents almost total coverage of all waterfront firms within the study area. Twenty-two firms (73.3 per cent) made direct use of their waterfront location, although 'use' varied from the transport of cargo via tugs and scows to the movement of materials via deep-sea vessels.

A second aggregate component of industrial marine transportation, characterized by indirect use, was the tendency to use central docking facilities or terminals. In these circumstances cargo shipped by water is transshipped to/from the firm by truck. Sixty-eight per cent of all firms had used central docking facilities within the past year. A large proportion of this indirect use was centred at the local Fraser-Surrey docks.

A commodity flow analysis incorporating both direct and indirect marine transportation flows showed

that the average firm received 50.5 per cent of inputs and distributed 18.9 per cent of products via ship. The large input figure is created by the movement of bulk materials (inputs of logs from coastal and upriver locations, sand and gravel from offshore islands, chemicals from abroad) and semi-finished products (steel and automobiles from Japan and Europe). The group of firms classified as 'light manufacturers', consisting of the wood and paper products sectors and fish processors, contributed most to create this 18.9 per cent marine output figure.

Although not a component of this analysis, industrial use of the Fraser River in production (e.g., wood and paper products sector, chemicals sector) and waste disposal most likely played a part in the locational decision of water-oriented firms. However, because of the ubiquity of this resource within British Columbia, the strength of its role in attracting manufacturing to one specific site is questionable.

Distribution Costs and Linkages

It was hypothesized that the distribution cost structure would constitute an important general element in the locational pattern of industry. Although it was suggested that a reduction in distribution costs within the metropolis has created an impetus for decentralization, differentials in the applicability of this factor may have allowed some activities with larger and more standardized linkages to decentralize faster than others.

A commodity flow analysis showed that the suburban industrial sample of firms retained substantial linkages within Metropolitan Vancouver. The average firm acquired 26.5 per cent of material inputs and marketed 38.1 per cent of outputs within the GVRD. The quantity of these aggregate linkages from a suburban industrial district suggests that transport costs to the central city industrial and consumer markets do not constitute a substantial cost burden, otherwise firms would gravitate to central city sites in order to reduce these costs.

A significant distinction was observed in the origin/destination commodity patterns by functional classification of industry. Light manufacturers (wood and paper products, fish processing sectors) had strong metropolitan and provincial input linkages and equally strong international output linkages. Conversely, heavy manufacturers (metal fabricating, non-metallic minerals, rubber, and chemical sectors) maintained strong input linkages overseas and essentially served only the local and Western Canadian markets.

Agglomeration

Industrial location theory suggests that activity should concentrate at the inner city for either market considerations or to take advantage of external economies of scale associated with the agglomeration of services and industry at this centralized location. However, if metropolitan distribution costs have been minimized, and firms are increasingly internalizing

their economies of scale, this centripetal force may no longer be in effect for capital-intensive manufacturers.

By analyzing the trends in industrial development at the Fraser River industrial community it can be concluded that the minimization of distributional costs has had the larger effect of these two forces on the dispersal of industry. New industrial development within the study area is increasingly concentrated at peripheral agglomerative nodes referred to as industrial parks. This new industry has retained strong linkages within the GVRD, is smaller in size, and makes more use of public docking facilities than established suburban manufacturers. Instead of internalizing economies of scale these newer firms have retained some inner city linkages, replaced others with linkages within their own community, and have created a new form of external linkage, dependence on central docking facilities for their marine transport requirements.

Capital Costs

Analysis has proven that suburban industrial areas have a significant land cost advantage over central city areas. However, until the creation and development of suburban industrial parks the initial investment involved in terms of site development at suburban locations proved prohibitive for most firms. With planned industrial communities, small-scale manufacturers can use larger land inputs while retaining a leasehold ownership status to reduce initial investment. Within

Metropolitan Vancouver it was observed that capital-intensive manufacturing was predominantly found in the suburbs where inexpensive land costs permitted the use of land-extensive production techniques. Within the municipalities of Delta and New Westminster, where the majority of the industrial sample firms were located, per capita investment in manufacturing activities was 47.3 and 50.9 per cent greater than within the central city industrial district.

Labour Costs

Although information regarding wage rate differences within Metropolitan Vancouver was difficult to obtain, inferences concerning the spatial variability of this factor of production may be drawn from the available data. In aggregate form, manufacturing communities in suburban Vancouver are at a labour cost disadvantage in comparison to the inner city industrial districts. Due to a labour supply deficit in the areal sub-units of Richmond, New Westminster, and Surrey, average annual earnings for manufacturing production employees within these areas exceeded Vancouver Downtown employee earnings by 17.5, 21.2, and 9.7 per cent respectively.

The spatial pattern of each occupational category is dependent on the overall wage rate (thereby influencing the mobility of labour) within that category. However, despite the differences in patterns, the same general direct relationship between distance from the labour surplus city centre and labour costs is

observed for most occupational categories.

Conclusions

This case study has provided evidence supporting the hypothesis that intrametropolitan movement of manufacturing has occurred as a result of differences in factor costs. In addition, it has examined a suburban industrial community and determined that although strong local linkages remain within the community a combination of reduced distribution costs and fixed capital cost advantages have resulted in the suburban growth of manufacturing activity.

With respect to the influence of the Fraser River on industrial decentralization, conflicting results prevent its presence from being considered as a principal factor in this process. Although a large proportion of existing industry transported commodities by ship, a significant proportion of these shipments are being coordinated through central docking facilities by inland manufacturers rather than by waterfront manufacturers. Trends in industrial development indicate that this indirect form of use by small-scale manufacturers is increasing.

The results are quite probably applicable to other suburban industrial districts. The spatial variability in wage rates and land costs is similar in other metropolitan centres, being dependent on labour and land supply variations throughout the metropolis. The phenomenon of reduced distribution costs is not specific

to one city but is, in general, related to the relative level of accessibility within the metropolis. The major difference between this and other study areas is the importance of marine transportation. Processing bulk products is less important in those suburban communities not adjacent to the waterfront. At these inland sites the absence of central marine docking facilities is reflected in a greater emphasis upon rail for long distance movement of commodities.

APPENDIX I

SURVEY QUESTIONNAIRE OF FRASER RIVER FIRMS, 1979-80

Canada Ports Project

Sponsored by University of Toronto/York University

Joint Program in Transportation

Survey of Firms in Vancouver Port Area

Research Supervisor: Dr. G.B. Norcliffe (416) 667-3087

NAME OF FIRM: _____

ADDRESS OF FIRM: _____

NAME AND BUSINESS PHONE NUMBER OF INTERVIEWEE (For future references if necessary): _____

BASIC PROFILE

1. (a) What year was this plant established? _____

   (b) Did this company establish this plant? Yes ☐ No ☐

   What year did this company take over this plant? _____

   (c) Was your company previously located somewhere else? _____

   (d) Why did you move from there? _____

2. What activities are carried on in this establishment?

   _____

   _____

   _____

   _____

3. What is the total land area occupied by this establishment?

   _____ square feet or _____ acres

   parking: _____% open space: _____%

   outside storage: _____% rail sidings: _____%

   buildings: _____% road allowance: _____%

4. What is the total floor space? _____ square feet

(i) Does the company have additional storage facilities?

a) adjacent to docks? Yes ☐ No ☐

If yes, where and why? What is their storage capacity?

_____

_____

b) elsewhere in the Vancouver Region? Yes ☐ No ☐

If yes, where and what is their storage capacity?

_____

_____

5. (a) Does this company have any other plants located in the Vancouver Region? Yes ☐ No ☐

(i) How many? _____

(ii) Where are they located? _____

(iii) How do their functions differ from this plant?

_____

_____

(iv) What commodities/products are moved between this plant and your other plants?

_____

_____

(b) Does this company have any other plants located in Canada?

Yes ☐ No ☐

↓

(i) How many? _____

(ii) Where are they located? _____

_____

6. Where is (i) your company's head office? _____

(ii) your company's regional office? _____

7. (a) How many employees work throughout the year in this plant?

_____

(b) Does your company hire any employees seasonally?

(is production variable) _____

INPUTS AND OUTPUTS

8. What are the major inputs of this establishment? P ☐

Sources of Input	Quantity per Year	Mode of Transport % Ship	Rail	Truck	Pipeline
A. INPUT: _____					
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
B. INPUT: _____					
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
C. INPUT: _____					
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
D. INPUT: _____					
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____
_____	_____	___	___	___	_____

APPENDIX I - Continued

9. What are the major products/services produced by this establishment?

P ☐

Location of Customer (Destination)	Quantity per Year	Mode of Transport% Ship	Rail	Truck	Pipeline
A. PRODUCT/SERVICE:					
B. PRODUCT/SERVICE:					
C. PRODUCT/SERVICE:					
D. PRODUCT/SERVICE:					

USE OF PORT FACILITIES

10. (a) What is the length of your firm's dockwall? _____

(b) Which berths are used by your firm? _____

(c) What equipment and facilities are on your quay?

_____

_____

_____

(d) Do you own your own equipment? Yes ☐ No ☐

↓

Who do you rent your equipment from?

_____

_____

11. What techniques are used for loading and unloading cargo?

_____

_____

_____

_____

12. (a) What is the high water level at your firm's berths? _____

(b) Have you found these depths to be sufficient at the present time and in the immediate future for your purposes?

Yes ☐ No ☐

↓

Explain more fully: _____

_____

_____

_____

13. What type of vessel is used in

(a) making waterborne shipments to you? _____

average size and capacity _____

(b) shipping your products elsewhere? _____

average size and capacity _____

14. (a) How many times per year do vessels deliver to you

from elsewhere on the Canadian western seaboard? _____

from elsewhere on the American western seaboard? _____

from abroad? _____

(b) How many times per year do vessels ship your products elsewhere

to other ports on the Canadian western seaboard? _____

to other ports on the American western seaboard? _____

to ports abroad? _____

15. Does the company have any transportation problems relating to the harbour/docking facilities? (Please list in order of importance)

_____

_____

_____

_____

OTHER TRANSPORTATION

16. On average, how many heavy truck trips are made per week in

(a) deliveries to this plant? _____

breakdown of origin

within G.V.R.D. _____%

outside of G.V.R.D., but within 150 miles of Vancouver _____%

elsewhere in North America _____%

(b) shipments from this plant? _____

breakdown of destination

within G.V.R.D. _____%

outside of G.V.R.D. but within 150 miles of Vancouver _____%

elsewhere in North America _____%

17. On average, how many railway shunts are made per week in

(a) deliveries to this plant? _____

breakdown of origin

within G.V.R.D. _____%

outside of G.V.R.D. but within 150 miles of Vancouver _____%

elsewhere in North America _____%

(b) shipments from this plant? _____

breakdown of destination

within G.V.R.D. _____%

outside of G.V.R.D. but within 150 miles of Vancouver _____%

elsewhere in North America _____%

18. Does your company have any problems relating to land transportation around the port area (road/rail/transit/pipeline/parking/loading: please list in order of importance)? P ☐

_____

_____

_____

_____

19. Are there any specific improvements you think will alleviate these problems?

P ☐

20. List any constraints that you feel could hamper the implementation of these specific improvements (e.g. financial/environmental/social).

21. Does you company have any difficulty in raising a workforce?

PROBLEMS OF LOCATION

22. What were the major reasons for your company choosing this port-area location? (Please list in order of importance) P ☐

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

23. Are there any other advantages or disadvantages to this site that have become apparent since your firm began operations here? P ☐

_____

_____

_____

24. If you were choosing a site today, would you still choose this site?

Yes ☐ ↓ No ☐ ↓

Why/Why not? _____

_____

_____

_____

↓

If not, where would you choose ? _____

_____

_____

25. Is the company considering expansion/relocation in the next 5 years?

Yes ☐ ↓

(i) Where?

a. __ at existing site

b. __ elsewhere in G.V.R.D.

c. __ elsewhere beyond G.V.R.D.

If b. or c., state location:

_____

(ii) Total relocation or branch plant?

_____

(iii) Why the chosen location? P ☐

_____

_____

_____

No ☐ ↓

Why not?

_____

_____

_____

_____

26. If your company currently has establishments at several locations within Canada, is it considering consolidating/rationalising the company's activities within Canada?

Yes ☐ ↓

How? _____

_____

_____

_____

Where? _____

_____

_____

No ☐

27. (a) What is the current book value of this plant (including machinery and equipment but excluding land value)?

_____

(b) Estimate the current land value on which this plant is situated.

_____

28. Does your firm own or lease this land? _____

If leased, from whom? _____

END

THANK YOU

APPENDIX II

QUESTIONNAIRE VARIABLE NAMES AND DESCRIPTIONS

Variable Name	Variable Description
IDENT	- An identification number assigned to each of the cases.
AGEFIRM	- Year the firm was established.
ESTTAKE	- Did current company establish plant or take over existing plant?
YEARTAKE	- If takeover, specify year of takeover.
PRELOCAT	- Was this company located elsewhere previously?
WHYMOVED	- Reasons for moving from previous location.
ACTVYSIC	- Principal functional activity engaged in at plant, by Standard Industrial Classification.
SIZESITE	- Size of plant site in acres.
PARKPCT	- Percentage of site designated as parking.
OTSTRPCT	- Percentage of site designated as outside storage.
BLDNGPCT	- Percentage of site designated as buildings.
OPNSPPCT	- Percentage of site designated as open space (not being used).
RAILPCT	- Percentage of site designated as rail access routes.
ROADPCT	- Percentage of site designated as road access routes.
FLOORSPC	- Total building floor space measured in square feet.
STORDOK	- Does plant have waterfront storage facilities
LOCSTORD	- If yes, location of waterfront storage.
STORGVRD	- Does plant have storage facilities elswhere in GVRD?
LOCSTORV	- If yes, location of storage.
GVRDFIRM	- Number of other branch plants located within GVRD.
LOCOTFRM	- Location of other plants.
DIFFUNC	- Differing functions of other plants.
PRODMOVE	- Do products move between this and other GVRD plants?
CANDFIRM	- Number of other branch plants located within rest of Canada.

HEADOFF - Location of head office.
REDOFF - Location of regional office.
EMPLOYEE - Number of full time employees at plant.
SEASONAL - Is there normally a seasonal fluctuation in production?
DOCKS - Does firm have its own docking facilities on site?
CNTDOCKS - Does firm make use of central docking facilities?
DOKLNGTH - Length of dock in feet.
BERTHS - Number of berths on site.
EQUIP - Own/Lease docking equipment.
WATER - Water level, at high tide, at berths.
WATRSUFF - Has water level been sufficient for firms needs?
TYPSHIPA - Type of vessel arriving at berths.
CAPSHIPA - Capacity, in tonnes, of vessel arriving at berths.
TYPSHIPD - Type of vessel departing from berths.
CAPSHIPD - Capacity, in tonnes, of vessel departing from berths.
SHIPCDNA - Number of ships arriving annually from Canadian West Coast.
SHIPUSAA - Number of ships arriving annually from U.S.A. West Coast.
SHIPELSW - Number of ships arriving annually from elsewhere.
SHIPCDND - Number of ships departing annually for Canadian West Cost.
SHIPUSAD - Number of ships departing annually for U.S.A. West Coast.
SHIPELSD - Number of ships departing annually for elsewhere.
PROBDOKS - Problems with harbour/docking facilities.
TRUCKARR - Number of fully laden supply trucks arriving at plant weekly.
TRKGVRDA - Percentage of these trips originating within GVRD.
TRKRADA - Percentage of these trips originating within 100 mile radius of GVRD.
TRKELSA - Percentage of these trips originating elsewhere.
TRUCKDEP - Number of fully laden trucks departing from plant weekly.
TRKGVRDD - Percentage of these trips destined within GVRD.

TRKRADD - Percentage of these trips destined within 100 mile radius of GVRD.

TRKELSD - Percentage of these trips destined elsewhere.

RAILARR - Number of fully laden rail cars arriving at plant weekly.

RALGVRDA - Percentage of these trips originating within GVRD.

RAILRADA - Percentage of these trips originating within 100 mile radius of GVRD.

RAILELSA - Percentage of these trips originating elsewhere.

RAILDEP - Number of fully laden rail cars departing from plant weekly.

RALGVRDD - Percentage of these trips destined within GVRD.

RAILRADD - Percentage of these trips destined within 100 mile radius of GVRD.

RAILELSD - Percentage of these trips destined elsewhere.

PROBLAND - Problems with land transportation system.

IMPRLAND - Suggested solutions to these problems.

PROBLBOR - Problems raising a work force at this location.

LOCDECON - Principal reason for locating at this site.

LOCDECTW - Secondary reason for locating at this site.

LOCDECTH - Third reason for locating at this site.

ADVSITE - Possible advantages of site since establishment.

DISSITE - Possible disadvantages of site since establishment.

SITEAGIN - Would company choose this site again, given the opportunity?

SITEYES - If yes, why?

SITENO - If no, why not?

NEWSITE - If no, location of preferable new site.

EXPNSION - Is the company considering an expansion of facilities within 5 years?

EXPNLOC - If yes, location of expansion.

RELCTION - Is the company considering a relocation of facilities within 5 years?

RELCTLOC - If yes, location of relocation.

CONSLRAT - Is the company considering a consolidation/ rationalization of operations within 5 years?

BOOKVALU - Estimated book value of plant, equipment, and property.
LANDVALU - Estimated land value of site/acre.
OWNLEASE - Own or lease property at site.
TOTIN - Total inputs, measured in tonnes, arriving at plant annually.
GVRD%IN - Percentage of total inputs from GVRD.
BC%IN - Percentage of total inputs from rest of British Columbia.
CAN%IN - Percentage of total inputs from rest of Canada.
USA%IN - Percentage of total inputs from U.S.A.
WORLD%IN - Percentage of total inputs from rest of world.
SHIP%IN - Percentage of total inputs arriving by ship.
RAIL%IN - Percentage of total inputs arriving by rail.
TRUCK%IN - Percentage of total inputs arriving by truck.
TOTOUT - Total outputs, measured in tonnes, leaving plant annually.
GVRD%OUT - Percentage of total outputs destined for GVRD.
BC%OUT - Percentage of total outputs destined for rest of British Columbia.
CAN%OUT - Percentage of total outputs destined for rest of Canada.
USA%OUT - Percentage of total outputs destined for U.S.A.
WRLD%OUT - Percentage of total outputs destined for rest of world.
SHIP%OUT - Percentage of total outputs leaving by ship.
RAIL%OUT - Percentage of total outputs leaving by rail.
TRUCK%OUT - Percentage of total outputs leaving by truck.
TOTAL - Total inputs and outputs, measured in tonnes.
GVRD% - Percentage of inputs and outputs from/to GVRD.
BC% - Percentage of inputs and outputs from/to rest of British Columbia.
CAN% - Percentage of inputs and outputs from/to rest of Canada
USA% - Percentage of inputs and outputs from/to the U.S.A.

WORLD%	- Percentage of inputs and outputs from/to rest of world.
SHIP%	- Percentage of inputs and outputs moved by ship.
RAIL%	- Percentage of inputs and outputs moved by rail.
TRUCK%	- Percentage of inputs and outputs moved by truck.
BRKBULK%	- Percentage of inputs and outputs, by weight, transferred to more than one mode of transportation within the GVRD.

APPENDIX III

PER CAPITA CAPITAL INVESTMENT MEASURE BY STANDARD INDUSTRIAL CATEGORY GROUPS, BRITISH COLUMBIA, 1978

S.I.C. Code	Industry	Per Capita Investment (000's $)	S.I.C. Code	Industry	Per Capita Investment (000's $)
1011	Slaughtering, Meat Processing	28.08	252	Veneer & Plywood Mills	18.65
1012	Poultry Processors	13.85	2541	Sash, Door, & Other Millwork	13.94
102	Fish Products	30.49	2543	Pre-Fabricated Buildings	24.89
1031	Fruit & Veg. Canners & Pres.	14.41	2544	Wooden Kitchen Cabinets	16.1
1032	Frozen Fruit & Veg.	13.33	256	Wooden Boxes	5.14
104	Dairy Products	43.6	258	Coffins & Caskets	7.86
106	Feed	27.81	2591	Wood Preservation	17.98
1072	Bakeries	15.21	2592	Wood Handles & Turning	38.99
1081	Confectionary Manu.	32.51	2593	Particle Board	38.99
1089	Misc. Food Processing	46.94	2599	Misc. Wood Ind.	13.77
1091	Soft Drinks Manu.	48.05	2611	Furniture Re-Upholstery & Repair	3.53
1092	Distilleries	121.81	2619	Household Furniture	15.53
1093	Breweries	34.67	264	Office Furniture	3.53
1094	Wineries	62.61	266	Misc. Furniture & Fixtures	14.04
165	Plastics Fabricating	15.78	268	Electric Lamp & Shades	5.56
174	Shoe Factories	6.49	271	Pulp & Paper Ind.	47.85
179	Luggage, Handbags, etc.	10.96	273	Paper Box & Bags	22.84
184	Cordage & Twine	12.58	274	Misc. Paper Converters	24.76
187	Canvas, Cotton & Jute Bags	7.36	286	Commercial Printing	16.15
189	Misc. Textiles	8.75	287	Platemaking, Typesetting	11.94
243	Men's Clothing	9.92	289	Publishing & Printing	30.83
244	Women's Clothing	13.31	291,2	Iron & Steel Mills/Pipe & Tube	34.01
249	Misc. Clothing	9.08	294	Iron Foundaries	17.96
2511	Shingle Mills	16.6	298	Metal Rolling & Casting	38.85
2513	Saw & Planing Mills	27.68	301	Boiler & Plate Works	13.49

APPENDIX III - Continued

S.I.C. Code	Industry	Per Capita Investment (000's $)
302	Fabricated Structural Metal	8.75
3031	Metal Doors & Windows	18.47
3039	Ornamental & Arch. Metal	17.25
3041	Metal Coating	12.11
3042	Metal Stamping & Pressing	31.16
305	Wire & Wire Products	35.56
306	Hardware, Tool, & Cutlery	24.89
307	Heating Equipment	21.01
308	Machine Shops	17.98
309	Misc. Metal Fabricating	17.17
311	Agricultural Implements	22.05
315	Misc. Machinery & Equipment	25.6
318	Office & Store Machinery	12.1
321	Aircraft & Aircraft Parts	10.85
3241	Truck Bodies	11.59
3242	Non-Commercial Trailers	21.44
3243	Commercial Trailers	17.07
325	Motor Vehicle Parts	36.51
327	Shipbuilding & Repair	15.86
328	Boatbuilding & Repair	10.61
333	Light Fixtures Manu.	16.87
335	Communications Equipment	24.2
336	Electric Ind. Equipment	33.27
338	Electric Wire & Cable	33.64
3391	Battery Manu.	24.54
352,3	Cement & Stone Products	43.69
3541,2	Concrete: Pipe & Structural Prod.	31.11
3549	Misc. Concrete Products	17.88
355	Ready Mix Concrete	15.66
3562	Glass Products	9.15
359	Misc. Non-Metallic Minerals	42.89
365	Petroleum Refineries	138.05
373	Plastics & Synthetic Resins	63.26
374	Pharmaceuticals & Medicines	34.98
375	Paint & Varnish	83.09
376	Soap & Cleaning Compounds	39.64
378	Industrial Chemicals	96.04
3799	Misc. Chemical Ind.	72.43
3911	Instruments & Related Products	14.48
3912,3	Clock, Watch, Ortho & Surgical App.	19.45
3914	Ophthalmic Goods	5.46
3915	Dental Laboratories	3.03
392	Jewellery & Silverware	10.85
393	Sporting Goods & Toys	11.38
397	Signs & Displays	8.26
3991	Broom, Brush & Mop Ind.	6.8
3994	Sound Recording Musical Inst.	5.97
3999	Other Misc. Manufacturing	7.27

SOURCES: compiled from Statistics Canada (1978); formula used to derive capital investment measure from Norcliffe and Stevens (1979)

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